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STATED PREFERENCE TECHNIQUES AND CONSUMER CHOICE BEHAVIOUR

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ABSTRACT

This PhD thesis examines the way in which individuals make choices during stated preference experiments (commonly referred subsets of which are called stated choice methods, conjoint analysis and trade-off analysis). Stated preference experiments ask respondents to rank, rate or choose between different product/service options, which are made up of a number of attribute mixes. The responses made by individuals within these experiments allow researchers to estimate consumer preferences.

This thesis traces the historical background of stated preference experiments, from the field of utility theory and experimental economics. An understanding of this historical background explains the reliance by practitioners on the assumption that respondents make rational choices during the stated preference experiment (where all the information presented to them within the experiment is traded off in order to come to an overall preference). In light of considerable research evidence within the field of psychology that consumers do not do not conform to this economic concept of rational choice, and recent criticisms within recent stated preference literature, this thesis identifies the choice strategies employed by respondents during three stated preference experiments, where attributes were represented in different ways.

Choice based stated preference experiments designed as the context for this research, measure consumers preferences for a newly developed fuel-efficient vehicle, with attributes currently unavailable in the marketplace. The experiments were presented to respondents as a series of choices between the newly developed vehicle and another currently available in the marketplace, described in terms of a number of attributes. The experiments were implemented using 'think-aloud' protocol to allow the identification of respondent's choice strategies.

The research successfully identifies the choice strategies employed by respondents during the stated preference experiments, and in support of recent criticisms within stated preference literature, finds significant deviations from the economic concept of rational choice. Furthermore, significant differences between the choice strategies employed by respondents are identified between the experiments where the appearance of the vehicles is represented in different ways. Using response data that is simulated to mirror the respondent choice strategies identified in each of the three stated preference experiments, the research tests the implications of these choice strategies on the estimation of consumer utility models. The research identifies significant differences between the parameter estimates derived from responses simulated assuming different choice strategy profiles. The research also identifies significant improvements in the estimated parameter values when the identified choice strategies are used in the analysis of the response data, rather than using the assumption of rational choice as an approximation. This suggests that stated preference practitioners might improve model estimation by identifying the choice strategies used by respondents to inform the analysis of stated preference response data.

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CHAPTER 1: INTRODUCTION TO THE RESEARCH AREA

1.1 Introduction

This PhD thesis examines the way individuals make choices during stated preference experiments (commonly referred subsets of which are called stated choice methods, conjoint analysis and trade-off analysis). Stated preference experiments ask respondents to rank, rate or choose between different product/service options, which are made up of a number of attribute mixes. The responses made by individuals within these experiments allow researchers to understand the preferences of these respondents. The ability to elicit individuals' responses and infer their preferences is of far reaching interest to many different parties. Louviere et al. (2000) states: *'Understanding the behavioural intentions of individuals to the actions of business and government will always be of interest to a wide spectrum of society'.*

Swanson (1998) provides three main uses for the technique, of which he considers the first two to be the most common:

- To estimate preference functions in their own right;
- To make market share forecasts, and to test sensitivity of shares to product specification;
- To study market segmentation.

However, confidence in the ability of current stated preference methods to elicit consumer preferences, and estimate subsequent market share forecasts effectively has been queried by research that questions the underlying assumptions made by stated preference researchers about the way in which respondents make choices (Ampt et al., 1995; Swanson, 1998). This aims to identify the choice strategies (the way in which respondents use the information presented to them) employed by respondents during a stated preference experiment. Furthermore, this thesis extends research undertaken by Nelson (1993; 1998), by focusing upon the impact of differing the ways in which attributes are represented in stated preference experiments on the choice strategies and resulting responses made by respondents. The research then considers the impact of any differences in the identified choice processes on the assumptions made about the analysis of stated preference response data.

This chapter introduces the thesis by describing the historical development and underlying assumptions relating to the use of stated preference techniques (section 1.2). This discussion of the historical development of the technique from within the field of economics provides an understanding of the assumptions relating to economic rational choice on which the technique is based. The chapter then introduces challenges that have been voiced within the field of stated preference techniques about the concept of rational choice assumed in the use of stated preference techniques (section 1.3). The impact of the representation of attributes on the responses and underlying choice behaviour of respondents within stated preference experiments is then considered (section 1.4). Leading from this discussion, the research questions addressed in this thesis are then presented and discussed (section 1.5), before the structure of the thesis is presented and explained (section 1.6).

1.2 Historical Development of Stated Preference Techniques

Stated preference techniques are based upon the principles of utility theory and economic rationality. The following sections explain the origins of these principles within the field of economics and the development of *revealed preference* and then subsequently *stated preference* techniques.

1.2.1 The Concept of Utility and the Principle of Economic Rationality

In the field of economics, the theory of choice is described in terms of utility. This concept of utility originates back to Jeremy Bentham in 1789 (Hargreaves Heap et al., 1992). Bentham's concept of utility is defined in hedonic terms, by a measure of pleasure that something produces (Kahneman, 1997). Others have interpreted utility as *'wantability'* (Fisher, 1918; Kahneman 1997). Kahneman (1997) suggests that:

> *'Economic analysis is more congenial to wants and preferences than to hedonic experiences and the current meaning of utility in economics and decision-making is a positivistic version of wantability: utility is a theoretical construct inferred from observed choices'.*

Samuelson (1938) suggests that an individual's behaviour could be seen as a series of choices. By comparing observed behaviour with available alternatives, Samuelson suggests that an individual's preferences (or utility function) could be inferred. The underlying assumption made in the inference of these preferences is that individuals behave and make choices *rationally*, and that this rationality allows human behaviour to be *predictable* (Albin, 1998). It is important here to clearly define the meaning of economic rationality. Albin (1998) states:

> *'For the economist, rationality has come to mean behavior that can be viewed as maximising some consistent mathematical function of behavioural and environmental variables... in particular, the economist will try and infer the objective function u from the agents observed behaviour, and then predict that her actions in the face of a change in the environment will follow the law x(a)'*

Within the field of utility theory and choice behaviour, individuals are assumed to maximise the level of utility (or expected utility) from a specified choice. The development of predictive behavioural models, from individuals' (agents) observed behaviour is considered within the field of utility as revealed preference techniques (McFadden 1973; Madden, 1993). The development of revealed preference techniques is explained within the following section.

1.2.2 Revealed Preference Techniques

The theory of choice presented by Samuelson (1938), which suggests that comparing observed behaviour with available alternatives can allow preferences to be inferred, has been subsequently developed in order to allow choice models to be estimated, and so predicted (see McFadden 1973; Madden, 1993 for detailed discussions of the main developments). These observed choices that an individual makes are referred to as

revealed preference data. Revealed preferences are gathered either through direct observation, or in surveys asking about actual behaviour.

Whilst revealed preference data has been used frequently to determine an individual's utility functions, the technique exhibits a number of severe limitations. The most prominent of these limitations are:

- Revealed preference techniques infer individuals' preferences from *observed* choices made within the market place. This means that responses can only be observed in response to current market conditions. It can be difficult to observe the effect of sufficiently large variations in the variables of interest using revealed preference data (Pearmain et al. 1991; Madden, 1993). Revealed preference data is typically restricted in the width of variation of current or past product/service attribute levels. As a result, researchers can only calculate accurately a small section of a consumer utility function.

- Given that revealed preference data is based on observed behaviour, the use of these techniques proves difficult when forecasting demand for new services or products (Pearmain et al., 1991; Louviere et al., 2000). It is not possible to observe individual's behaviour in response to market conditions that do not yet exist.

Clearly the use of revealed preference techniques for identifying consumer preferences and/or forecasting demand in some scenarios is difficult. It is largely as a result of these problems encountered using revealed preference techniques that researchers have developed alternative methods of estimating consumer utility functions, and so forecast demand. These alternative methods rely on the observed responses individuals make to hypothetical choices. The origins of these *stated preference* techniques are discussed in the following section.

1.2.3 Early Experiments Using Hypothetical Choice

An alternative method to examining observed behaviour to determine consumers' preferences is to examine consumers' responses to hypothetical choices. This section considers the origins of these alternative methods, to provide an understanding of why *stated preference* techniques are underpinned by the principles of economic rationality, held within the field of economics and utility theory.

Researchers working within the field of utility theory were by the first half of the twentieth century trying to find ways of determining an individual's utility measure for goods and services and so establish consumer preferences. In 1941, Thurstone carried out research into how to determine individuals' indifference curves. Indifference curves show combinations of goods that provide a consumer with equal utility. He reported an experiment where individuals were asked to make hypothetical choices about different commodity bundles that consisted of hats and coats, hats and shoes, or shoes and coats. This is the earliest reported experiment asking respondents to make hypothetical choices such as those presented in stated preference experiments. Thurstone reported in detail the responses of one individual, and concluded that the trade-offs made could be adequately represented by indifference

curves. However, this experiment is strongly criticised by Wallis and Friedman (1942). They state:

> *'It is questionable whether a subject in so artificial an experiment situation could know what choices he would make in an economic situation; not knowing, it is almost inevitable that he would, in entire good faith, systemise his answers in such a way as to produce plausible but spurious results ... for actual stimuli... Questionnaires or other devices based on conjectural responses to actual stimuli do not satisfy this requirement. The responses are valueless because the subject cannot know how he would react'.*

Rousseas and Hart (1951) describe a later experiment that they carried out as a response to the work reported by Thurstone and the subsequent criticism made by Wallis and Friedman. They aimed to carry out a choice experiment that provided a more realistic choice by asking respondents to choose between different breakfast menus. Rousseas and Hart also conclude that individual's preferences can be successfully measured using hypothetical choice experiments. This conclusion is supported by research carried out by Mosteller and Nogee (1951) that looked at expected utility theory. They suggested that laboratory experimentation provides valuable opportunities to examine behaviour that is *'uncomfounded by other considerations'*.

Despite the support of early experiments, research into individual choice that made use of responses to hypothetical choices (stated preference techniques) were not used for commercial application until the 1970s. Further developments within the field of utility theory, that led to a renewed interest in the use of experiments using hypothetical choices for commercial use are discussed in the following section.

1.2.4 Stated Preference Techniques

Experiments using hypothetical choice were used in the first half of the twentieth century, as discussed earlier, in order to develop a greater understanding of utility theory. An extension to utility theory, which Salvatore (1997) describes as the *'characteristics approach to consumer theory'* was pioneered by Lancaster (1966), and postulated that consumers demand a good according to its *characteristics or attributes* of the good, and it is these characteristics that give rise to its utility. This development led to the further development of experiments using hypothetical choices, where these choices were described in terms of the *attributes* of the goods or services that they described.

Examples of the early commercial use of these experiments were published in the early 1970s and were then commonly referred to as 'conjoint analysis' (Davidson (1973); Louviere et al. (1973)).

In 1978, Green and Srinivasan formally defined these types of evaluation techniques as:

> *'Any decompositional method that estimates the structure of a consumer's preference... given his/her overall evaluation of a set of*

> *alternatives that are pre-specified in terms of levels of different attributes'.*

From the early 1980s researchers were using the method more widely, and within Europe at least were commonly referring to the method as *'stated preference techniques'*. This has become a popular term, largely because of the clear contrast it portrays to *'revealed preference techniques'*. Sheldon and Steer (1982) provide an early publication outlining the use of the technique.

Prior to 1982, the emphasis of stated preference techniques had been on judgemental tasks, in which respondents were asked to rank or rate a number of attribute mixes associated with a particular choice context. However it was not until the publication of a paper by Louviere and Hensher (1982) that stated preference techniques became better known. Louviere and Hensher's paper emphasised the use of stated preference techniques that incorporated choice experiments. Louviere (1988) suggests that discrete choice presents a more realistic judgement for the respondent:

> *'One can design choice or allocation experiments to mimic real choice environments closely. This is important because individuals in real environments do not rank or rate travel alternatives; they choose one of them, or they choose not to choose any alternative'.*

Louviere (1988) also suggests that choice experiments produce data that is easier to analyse:

> *'Discrete choice tasks impose no order or metric assumptions on response data... ...choice experiments discussed by Louviere and Hensher (1982) and Louviere and Woodworth (1983) allow travel choice researchers to estimate choice models that are consistent with transport planning and forecasting practice'.*

As choice-based stated preference techniques are now probably the most commonly used (Pearman et al, 1991; Louviere et al., 2000; Swanson, 1998), it is in this area that this thesis focuses.

The performance of stated preference techniques when compared to revealed preference data was perceived as impressive, by the UK Department of Transport's Value of Time Project (MVA, ITS, TSO, 1987), and this resulted in the acceptance of the method by the Department of Transport. This influential acceptance had an important positive impact on the frequency of the method's usage in the UK. Since then, stated preference techniques have become widely applied within a variety of areas.

Examples of the application of the technique include:

- Modal split modelling within the transport sector (Bradley, 1988; Fowkes and Wardman, 1988; Hensher, Barnard and Truong,1988; Louviere and Hensher,1982; Louviere et al.,1973)
- New product development and forecasting (Louviere, 1986; Green, Carroll and Goldberg, 1981)
- Public valuation of environmental impact (Nelson, 1998).

Whilst the techniques grew in their usage, some scepticism has remained about the reliance upon respondents' 'stated intentions', rather than actual behaviour. Madden (1993) describes the scepticism that has been raised '*concerning the application of analyses on 'real world' policy*':

> *'An important aspect of the risk is the concern that stated and revealed preferences may diverge systematically because of bias in subjects' responses or due to errors due to over complex experimental designs'*

In addition, further criticisms have been made of the underlying rational choice behaviour of respondents that is assumed in the design and analysis of stated preference experiments. The following section considers in more detail the underlying assumptions made by stated preference researchers relating to the choice behaviour of individuals, stemming from the field of economics and utility theory in which stated preference techniques were developed. An understanding of some of the criticisms of this technique is then presented and a possible link is made with the impact of differing ways of representing attributes on individuals` responses within the experiments.

1.3 Stated Preference Techniques and the Theory of Choice

1.3.1 The Assumptions Made About Respondents Choices in Stated Preference Experiment

In section 1.2.1 the concepts of utility and economic rationality were outlined. These principles form the basis of the theory of choice presented within the field of economics, and assumed within stated preference research. This section considers in more detail the consumer choice process assumed by stated preference researchers.

Figure 1 (overleaf) presents the stages in a purchasing decision process that are undertaken by an individual consumer as described by Louviere et al. (2000), and consistent with the economic theory of choice. Stages 1-4 are those parts of the decision process that respondents are asked to undertake as part of a stated preference experiment. The stages of the assumed consumer decision-making process are now discussed in terms of how respondents are assumed to make a decision within a stated preference experiment.

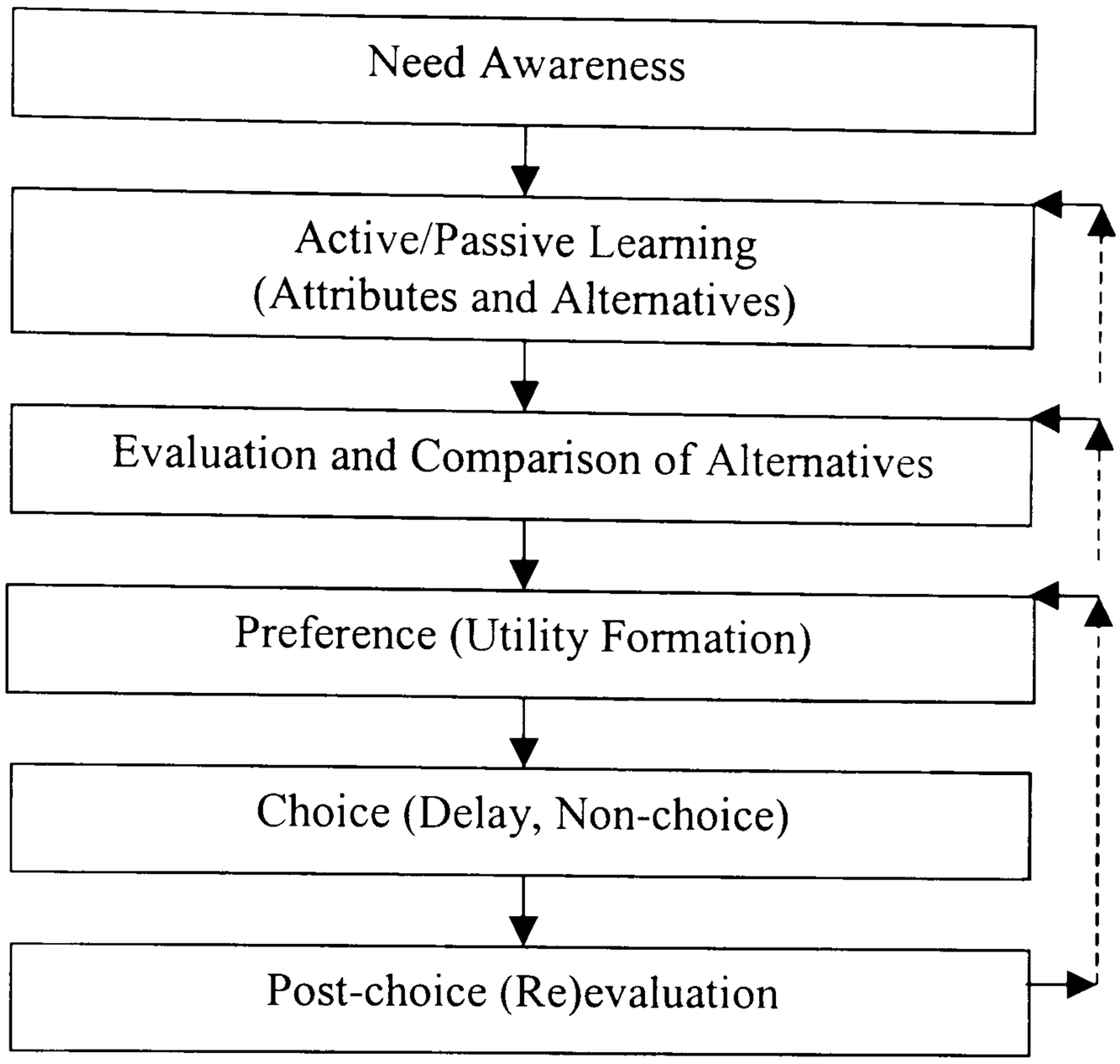


Figure 1: Overview of the Consumer's Choice Process (Louviere et al, 2000)

Having assumed to be aware of the need for a product or service, a respondent is expected to undertake a period of active/passive learning about the available alternatives that will satisfy their identified need. Within the context of the stated preference experiment, it is expected that the respondent would examine all the available information presented to them. During this stage Louviere et al (2000) suggest that consumers learn about *'the attribute values offered by the products, and any associated uncertainties'*. During the evaluation and comparison of the alternatives, consumers form a utility function (sometimes also termed a decision rule or objective function). Under the assumption of economic rationality (described in section 1.2.1) this would mean that consumers aim to maximise their utility, which *'involves valuing and trading-off product attributes that matter in the decision'* (Louviere et al., 2000). This type of choice that makes use of trade-offs is also known as *compensatory*. Stated preference responses that appear to the researcher to be 'irrational'(non-compensatory or non-utility maximising), are traditionally removed from the sample (Pearmain et al., 1991). Subject to budget and/or other constraints, the consumer is then assumed to develop a preference ordering from the available choices. The respondent within a stated preference experiment then has the choice whether to choose one of the options they are presented with, or possibly decide not to choose any of the options presented to them.

The Louviere et al (2000) choice process described above clearly contains a chain of internal mental elements that are linked to the multiple attributes of alternative purchase options. It assumes that individuals trade-off an improvement in one attribute against a worsening in another, in line with the assumption of utility maximisation, and the rational consumer. These underlying mental processes are not

observed by the researcher. The data collected from the stated preference experiment would normally take the form of response data – the stated preferred choice to each of the choice scenarios presented within the experiment. This response data is analysed, and inferred trade-offs made by comparison of these responses to changes in the attributes presented within the experiment.

The following section considers some of the challenges levelled at this assumed economic rationality assumed within stated preference techniques, and then continues to consider the potential impact of these challenges on the usage of the technique.

1.3.2 Challenges to the Assumed Economic Theory of Choice

This research examines the way in which respondents make choices in stated preference techniques. Sections 1.2.1 to 1.3.1 explained that research within the field of stated preference techniques have relied upon the assumption that respondents make rational choices. However criticisms of the rational choice model assumed within the field of economics (where stated preference techniques evolved) were being presented, from within the psychology literature by researchers such as Simon from as early as 1957. Simon (1990) states:

> *'because of the limits on their computing speeds and power, intelligent systems must use approximate methods to handle most tasks. Their rationality is bounded'.*

Criticism of the assumed rational choice model from researchers within the field of stated preference techniques were not made until 1978. Green and Srinivisan (1978), reporting on wider decision-making research, introduce the criticism to the stated preference literature:

> *'research has found that some consumers use each of the models* [compensatory models and heuristic models] *but generally prefer those requiring simpler processes'.*

Ampt et al (1995) describe respondent's use of heuristics to be '*rules of thumb, some specific, some general, which are often known as satisficing approaches to decision-making*', and support Green and Srinvisan's assertion that respondents may use non-compensatory choice processes. In a later publication in 2000, Ampt et al then go further to state:

> *'We can probably say with certainty that people do not, in general, use a linear compensatory choice function when making decisions, and indeed may only do so on a minority of occasions when faced with particularly simple problems'.*

This is further supported by research by Timmermans (1993), who reports that increasing the complexity of choice tasks increases the use of information screening by individuals – and so deviates from a non-compensatory model of choice.

In light of the discussion of the impact of task complexity causing respondent's rationality to be bounded, and given the problems associated with estimating the implied preferences of respondents from non-compensatory choices, Ampt et al (2000), provide some guidelines for the improvement of stated preference practice. They include the following suggestions:

- Structure the stated preference task around the current experience of respondents
- Try to maintain a high degree of realism
- Do not present too much information to respondents at once

These guidelines focus on the way in which choice scenarios are presented to respondents. The presentation of attributes within the stated preference experiment, and their impact of respondent choices processes, is considered in more detail in the next section.

1.3.3 Representation of Attributes in Stated Preference Experiments and the Possible Impact on Choice Behaviour

One problem relating to the hypothetical nature of stated preference techniques is how to represent the object of interest to the respondent. In the previous section, and in light of the criticisms of the rational choice model assumed by stated preference researchers, Ampt et al's (2000) guidelines were presented that emphasised the importance of maintaining the realism of the choice context. This section considers different ways of representing attributes within stated preference experiments, and their possible impact on the respondent choice process and their subsequent responses.

One method of attribute representation described by Green and Srivinsen (1978) that attempts to provide a detailed understanding of the attributes to the respondent in a stated preference experiment is that of a paragraph description approach. They suggest that this approach provides a:

> *'realistic and complete description of the stimulus ...[but] a significant drawback of this procedure is that it limits the total number of descriptions to a small number, so that parameter estimates are likely to be inaccurate at the individual level'.*

Hauser and Urban (1977) provide a rare published example of the use of the paragraph description approach that looks at innovative product design.

Green and Srinivasan suggest that when writing in 1978, verbal descriptions (text cues) were a more commonly used method of representing attributes in stated preference experiments. This trend has continued with most examples of stated preference experiments using verbal descriptions (for example see Pearmain et al. 1991). However, Bradley (1988) suggests that verbal descriptions might not always be the clearest way of representing attributes to a respondent in stated preference experiments:

> *"Certain types of attributes can often be perceived more clearly if presented in forms other than verbal descriptions. For example, qualitative factors can often be depicted by drawings or photographs....."*

Green and Srivinsen (1978) support this view, suggesting that the use of pictorial representations have several important advantages over verbal cues:

- Information overload is reduced since the respondent is not required to read and then visualise large quantities of information.

- Higher homogeneity of perceptions of such things as car roominess or trunk capacity is obtained across respondents.

- The task itself is more interesting and less fatiguing.

The above comparison made between pictorial representations and verbal cues suggests that the way in which attributes are represented may alter the informational complexity of the choice presented to the respondent. Section 1.3.2 presented stated preference literature that highlighted the possibility that increasing informational complexity might impact upon the assumption of compensatory (utility maximising) choice processes by respondents (Swanson, 2000; Ampt et al, 1995; Timmermans, 1993). This literature suggested that increasing choice complexity might cause respondents rationality to become bounded, resulting in increased use of non-compensatory choice processes. No literature has been found that provides empirical evidence of the impact of the method of attribute representation type on respondents' choice processes. However, a small number of studies have examined the link between attribute representation types and individuals' responses in stated preference experiments.

Hauser and Urban (1977) provide a rare published example of the use of the paragraph description approach that looks at innovative product design. This study also compares the use of pictures with the use of pictures and words. It found that:

> *'a combination of pictures and words produced roughly the same results as the purely verbal approach, but that respondents took less time to complete the pictorial task'.*

These findings are supported by Louviere et al. (1987) whose examines the case of a forest park choice in the USA. This study also tentatively suggests that there is little difference between verbal versus visual representation of attribute levels.

However, Nelson and Towriss (1995), also describe a study that looks at the difference between visual and verbal representations of attributes in research that focused upon the demand for light rail transit (LRT) in Manchester. This study however found that responses differed depending upon the type of representations used. Follow up interviews with the respondents suggested that:

> *'Some individual's find it difficult to make choices based on the abstract nature of attributes represented in a textual form and seek to add realism by embellishing the information given to them in the experimental setting'.*

Further research carried out by Nelson (1998) that compares the use of pictures and text in a stated preference exercise used for environmental evaluation. This study identified that representation had a significant impact on the stated preference results, but that this impact was overwhelmed by the effect of preference variation between cluster groups within the respondent samples. Nelson (1998) commenting on the impact of attribute representation type on stated preference results reports that:

> *'Due to the 'noise' created by the Group impact it was not possible to explain how or why this phenomenon occurs. Further research therefore, remains of great importance and is required to define the impact of information bias on direct survey techniques'*

Evidence that the form of attribute presentation used in a stated preference experiment affects the responses made by an individual has been found to be inconclusive. Few publications examine the effect of different forms of attribute presentation, and these publications have found differing results. This research aims to directly examine the impact of attribute representation type on both the respondent choice process and individuals responses during stated preference experiments.

1.4 The Research Area

This PhD thesis examines the way individuals make choices during stated preference experiments. This reflects criticisms within recent stated preference literature of the assumption of rational choice made by stated preference researchers in the analysis of stated preference response data. This leads to the first of the research questions to be addressed in this thesis:

> *What choice strategy is used for each choice scenario presented to the respondent during a stated preference experiment?*

This research also aims to further research by Nelson (1995, 1998) that identified differences in the responses made by individuals within stated preference experiments, when presented with attributes that were represented in different ways. This research, whilst providing an important contribution in questioning the impact of representation type on the choices made by respondents, failed to uncover the underlying choice process of respondents in response to the way in which attributes are represented. This is the second area that is addressed by this research, leading to the following research question:

> *Does the way attributes are represented, using picture or text, affect the choice strategy employed by a respondent during a stated preference experiment?*

The third research question presented within this thesis aims to examine the impact of the identified choice processes used by respondents on the estimation of consumer utility models. This question is addressed in order to consider the importance of understanding consumer choice strategies in the use of stated preference experiments. The third research question addressed in this research is:

> *Does the choice strategy employed by respondents during stated preference experiments affect the estimated utility models, and resulting utility estimates?*

The following section presents a summary of the research questions addressed within this thesis, before the structure of the thesis is discussed at the end of the chapter.

1.5 Statement of the Research Questions

The research questions to be addressed within this PhD thesis are as follows:

1. *What choice strategy is used for each choice scenario presented to the respondent during a stated preference experiment?*

2. *Does the way attributes are represented, using picture or text, affect the choice strategy employed by a respondent during a stated preference experiment?*

3. *Does the choice strategy employed by respondents during stated preference experiments affect the estimated utility models, and resulting utility estimates?*

1.6 Structure of the Thesis

This thesis comprises of nine chapters. A description of the structure of the thesis is shown in figure 2.

Chapter 2 presents the theoretical background to the research area. This positions this research within the literature relating to consumer decision-making, and criticisms of the rational theory of choice assumed within stated preference experiments.

Chapter 3 explains the research methodology and design that aims to address the research questions presented within the previous section. This chapter describes the philosophical assumptions that this research adopts, explains the methodological approach adopted, and presents the adopted research design for this thesis.

Chapter 4 develops the context of this research – the decision to purchase a new car. This chapter identifies those vehicle attributes that influence new car buyer's purchasing decisions. These identified attributes are then used to inform the design of a stated preference experiment, explained in chapter 5.

Chapter 5 describes the development of a stated preference experiment that presents a purchasing choice between two vehicles, and provides the context for this PhD research.

Chapter 6 describes the design and implementation of a think-aloud (or verbal) protocol during the three stated preference experiments discussed in chapter 5. The analysis of this think aloud protocol allows the identification of the choice processes used by respondents during the stated preference experiments (*research question 1).* The chapter also examines the impact of the different representation of attributes within the three stated preference experiments on the choice processes used by respondents *(research question 2).*

Chapter 7 analyses the response data collected during the stated preference experiments. This analysis allows the estimation of consumer utility models. The choice processes used by respondents during the three different stated preference experiments is compared with the estimated utility models associated with each of the three experiments *(research question 3).*

Chapter 8 describes a further investigation of the impact of differing choice strategies used by respondents in stated preference experiments, on the estimation of consumer utility models (*research question 3).* This is achieved through the analysis of data simulated to represent responses made by employing choices strategies that mirror those made by individuals within each of the sample groups. The chapter also examines the suitability of the assumption of utility maximising choice strategies as an appropriate approximation in the analysis of stated preference choice data.

Chapter 9 presents the conclusions of this thesis. This discusses the findings of the thesis in terms of addressing the research questions, examines the contribution to knowledge of these findings, and presents a critique of the research presented within this thesis.

At the beginning of every chapter, a modified version of figure 2 is presented, in order to highlight the position of the chapter within the thesis structure.

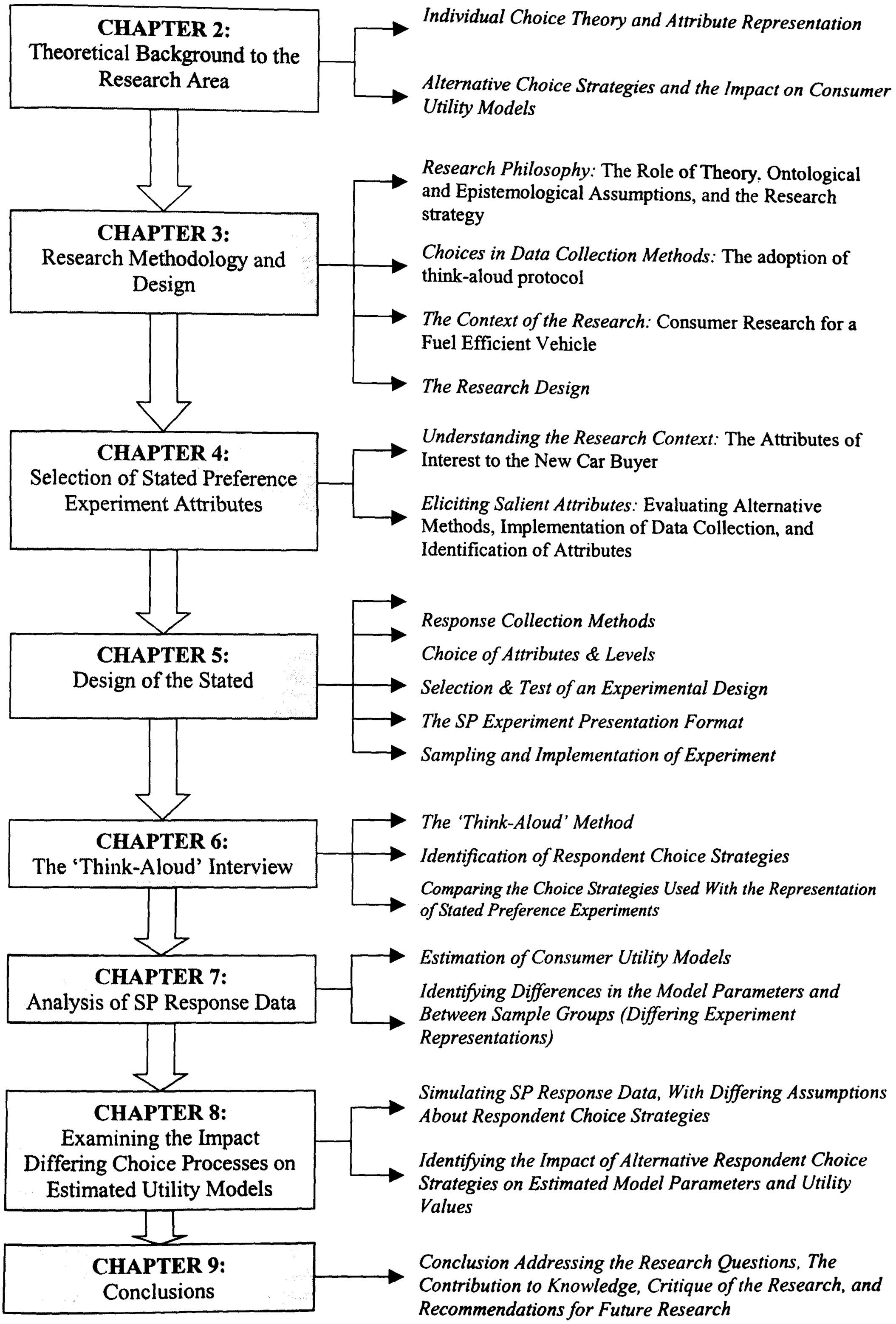


Figure 2: The Structure of the Thesis

CHAPTER 2: THEORETICAL BACKGROUND TO THE RESEARCH AREA

CHAPTER 2:
Theoretical Background to the Research Area

- *Individual Choice Theory and Attribute Representation*
- *Alternative Choice Strategies and the Impact on Consumer Utility Models*

CHAPTER 3:
Research Methodology and Design

CHAPTER 4:
Selection of Stated Preference Experiment Attributes

CHAPTER 5:
Design of the Stated

CHAPTER 6:
The 'Think-Aloud' Interview

CHAPTER 7:
Analysis of Response Data

CHAPTER 8:
Examining the Impact Differing Choice Processes on Estimated Utility Models

CHAPTER 9:
Conclusions

2.1 Introduction

Chapter 1 introduced the research area of this thesis, which examines the way in which respondents make choices during stated preference experiments. This research aims to identify the choice strategies employed by respondents within each choice scenario presented to them within a stated preference experiment *(research question 1)*, identify any differences in the choice strategies employed by respondents when presented with stated preference experiments where attributes are represented in different ways *(research question 2)*. The research also aims to identify the impact of any differences in the choice strategies used by respondents on the consumer preference models estimated from stated preference data *(research question 3)*.

This chapter positions this research within the relevant literature from the field of stated preference research, and the contrasting research from economics and psychology. The first section of this chapter addresses literature relating to the first and second research questions, by re-examining the assumed choice theory adopted by stated preference researchers and presents further criticism of the theory from the field of psychology. In examining the influences on individual choice behaviour, this research also discusses the possible impact of attribute representation on the choice behaviour of respondents within stated preference experiments. The second part of the chapter examines the possible impact of respondents using non-utility maximising choice strategies on the estimation of consumer utility models. This section draws upon literature from the stated preference field, and from wider economic principles.

2.2 Individual Choice Strategies and Attribute Representation (Research Questions 1 and 2)

This section draws upon contrasting literature relating to individual choice. These differing views on the processes that underpin consumer behaviour form the basis for the first two research questions presented within this thesis, which aim to identify the choice strategies used by respondents within stated preference experiments where attributes are represented in different ways.

2.2.1 The Rational Choice Model

Models of consumer decision-making in the field of economics are based upon the principles of rationality (sometimes referred to as instrumental or substantive rationality), and utility maximisation. In chapter 1, the origins of stated preference techniques were positioned within the field of economics and utility theory – which explains why it is upon these assumptions of economic rationality and utility maximisation that the analysis of stated preference response data relies. This section explains the assumptions (often referred to as axioms) associated with the rational model in more detail, before criticism of the model is presented through the explanation of occasions when observed behaviour has broken these assumptions.

Instrumental (or economic) rationality is defined as the choice of actions that best satisfies a person's objectives (Hargreaves Heap et al., 1992). This presumes that an individual with a variety of objectives is capable of comparing the satisfaction of these various objectives so as to come to an overall assessment. It has traditionally been assumed that these objectives can be ordered on a single scale by comparing the pleasures of satisfying them. The name given to this measure is 'utility'.

Hargreaves Heap et al. (1992) describe how in the rational theory of choice, individuals are assumed to hold preferences that are related to the perceived level of utility associated with different options. The integration of these preferences is revealed in a preference ordering which determines action. Instrumentally rational action is defined through placing certain restrictions on these orderings (axioms of rationality). Swanson (1998) presents a summary of the three key axioms underlying rational choice models, the axioms of: transitivity; dominance; and invariance of preferences. These can be described in terms of three hypothetical choice options: options A, B, or C.

- *Transitivity of preferences:* This asserts that if A is preferred to B, and B is preferred to C, then A will be preferred to C
- *Dominance of preferences:* If A is preferred to B in all respects, then A is preferred to B
- *Invariance of preferences:* Preferences are independent of the method used to elicit them, and choices between options are independent of their presentation or description

When these restrictions are met, a preference ordering can be represented by a utility function (Hargreaves Heap et al., 1992). It is upon the above assumptions that economists base their theory of rational choice. However empirical research within the field of experimental economics has observed choices made by individuals that present interesting anomalies to the axioms of choice presented within assumed economic rationality. These anomalies stem from criticism made of the model by Kahneman and Tversky (1979) that preferences to situations are sensitive to the way in which the situations are framed. They present an extension to the rational choice model to account for evidence that:

- Gains are treated differently to losses;
- Outcomes with certainty tend to be over-weighed compared to those with lesser probabilities;
- The structure of a problem (such as reference points) may affect the choices made.

Further advancement of this work has been provided by Kahneman (1997), in the concept of the endowment effect. Kahneman's work suggests that people will demand more to sell an item they own than they will to pay to acquire it (Swanson, 1998). Further examples of prospect theory and the impact of framing effects are also presented by Knetsch and Thaler (1990); Allais (1990); and Rabin (1998).

These studies provide examples of empirical research within the field of economics that tests the assumptions underlying rational models of behaviour. However, these

observed anomalies have been rationalised, by explaining how people value choice differently when they are presented differently. This therefore maintains the concept of utility maximisation assumed within the theory of rational choice.

Swanson (1998) comments on the contrasting views of economists and psychologists in their examination of individual choice behaviour. He suggests that economics:

> *'is concerned with theory and falsification... ...experimental psychologists seem to be less interested in general theory and are more motivated by the study of process'.*

The following sections consider alternative models of decision making that originate from the field of psychology, which describe decisions in terms of the *process* that they employ.

2.2.2 Process Models of Consumer Decision-Making

Decision process, or logical flow models of decision-making models have prevailed in study of consumer behaviour since they first appeared in the 1960s. These types of decision-making present the buying process as a series of sequential steps that represent the cognitive processes of individuals (Chisnall, 1994). Tuck (1976) suggest that these models can be likened to computer flow charts, and follow a process of pre-purchase mental events and processes. Early examples of these types of model are provided by Kotler (1967), and Engel, Kollat and Blackwell (1968) and are depicted in Appendix A, and a further description of such models adapted from Foxall (1983) and Tuck (1976) is presented in Appendix B.

These simple, process models of decision-making do not contradict the axioms of the rational choice model (as presented in section 2.2.1). Multivariate models of decision-making however, formally describe a wide number of conflicting influences that affect an individual's choice process, and represent an extension to the logical flow models previously described. Chisnall (1994) suggests that in this type of model,

> *'the consumer is typified as a problem-solver aroused by some stimuli who has to cope with information and inputs from a variety of sources. Information is processed; economic, socio-cultural, and psychological influences are evaluated; and the result leads to a purchase – immediate or postponed – or to a rejection of a particular product or brand of product'*

Well known theoretical models that include these wider source of inputs into the decision making process have been developed include those by Howard and Ostlund (1973); Engel , Kollat, and Blackwell (1968); Nicosia (1966) and Andreasan (1965). These models are typically represented by very complicated diagrams, representing all the different economic, socio-cultural, and psychological influences on the purchasing process. McCracken (1994) described the diagrams associated with this type of model as *'an elaborate diagram filled with boxes and arrows... resembling nothing so much as the wiring instructions for an unusually complicated piece of electronic technology'.*

These multivariate models introduce elements that influence the decision-making process that might be considered by economists to be non-rational factors relating to choice. There is an important difference in the conceptualisation of the term 'rationality' between economists and psychologists. *'In economics, rationality is viewed in terms of the choices it produces; in the other social sciences it is viewed in terms of the processes it employs'* (Simon, 1976, 1982). *'The rationality of economics is substantive rationality, while the rationality of psychology is procedural rationality'* (Simon, 1996).

These psychological multivariate models are open to criticism with regard to the untested nature of the complex relationships described between elements affecting decision-making (Tuck, 1976; Foxall, 1983; Chisnall, 1994). However, despite these criticisms, the models' identification of what are considered non-rational influences on the decision process are useful in highlighting the perhaps over simplistic assumptions relating to rational choice models (Kamarck,1983). These criticisms have been further developed in more recent academic debate, and will be considered in the following sections, in the context of three stages of the decision-making process:

- Information search and retrieval
- Perception
- Information processing (choice strategies)

2.2.3 Information Search and Retrieval

The theoretical difficulty with rationality arises firstly over the informational structure of decisions made (Hargreaves Heap et al, 1992) - that is the availability or cost of information on which decisions are made. The problem may not be obvious at first, because it is tempting to think that the investment in acquiring information can be subjected to an instrumental calculation. For example, economists suggest that individuals invest in information up to the point at which marginal benefit in terms of additional utility, matches the marginal cost in terms of utility that might have been gained from other activities undertaken instead. However, Hargreaves Heap et al (1992) ask *'How is an individual to know the marginal benefits of further information acquisition, without knowledge of the full information set?'*. They state that whilst it is possible to suggest that an individual has subjective beliefs about the benefits from additional information, this introduces an arbitrary element into the description of action.

Solomon (2002) suggests that the assumption of rational search is not always supported. He presents several examples of information search that deviates from the idea of rational search:

- *Perceived risk*: respondents are considered to engage in information search more when the purchase of a product is considered to entail some kind of perceived risk. Solomon describes a series of different types of possible risk associated with purchasing decisions: monetary risk, functional risk, physical risk, social risk and psychological risk. In contrast, those purchasing decisions

that are considered low risk by an individual are considered to be associated with lower levels of information search by consumers.

- *Variety seeking*: Solomon also suggests that individuals do not always search for information rationally, because they are motivated to simply to try new products.

It is also possible that respondents may not utilise information that is available to them at no, or limited cost. Research by Verplanken et al (1998) suggests that this may be true in the case of habitual behaviour. Instrumentally rational action (as assumed in stated preference techniques) assumes that behaviour is dependent upon a discrete choice, which is considered upon available information. Verplanken et al (1988) suggest that when behaviour is *'repeatedly and satisfactorily executed and becomes habitual, it may lose its reasoned action'*. This therefore suggests that the type of information search employed be an individual is specific to the type of choice being made.

The next section considers how information available to the decision maker might be perceived.

2.2.4 Perception

The information available during the process of decision-making may be perceived in different ways by different individuals. Solomon (2002) describes perception as the process in which sensations are absorbed by the consumer and used to interpret the surrounding world. Similarly, Roth (1986) presents a clear definition of the term perception:

> *'The term perception refers to the means by which information acquired via the sense organs is transformed into experiences of objects, events, sounds, tastes etc'*

Section 2.2.1 presented research within the field of economics that had identified that people perceive and comprehend information differently depending upon how it is presented to an individual. A notable example from literature relates to the way in which individuals in choice experiments can be observed as perceiving a different value associated with choice options that are described in terms of losses rather than gains (Swanson, 1998; Ampt et al, 1995; 2000).

Another difference between research within the field of psychology and the theory of rational choice relates to the concept of selective perception. McGuire (1976) suggests that individuals implement selective perception in order to deal with the problem of sensory overload. McGuire suggests seven different strategies employed by individuals that result in our perceiving a subset of all the information that reaches our receptors:

- *Lumping or chunking* - for example, instead of seeing a group of trees, we see a forest.

- *Shifts in perception* – where an individual shifts their perception between one and another part of a scene.

- *Temporary storage* – temporary storage of information in the short-term memory allows an individual to part the present information into some kind of 'pushdown' list so that the information can be dealt with at a less hectic moment.

- *Distribution of attention* – less sharply but more broadly, or alternate between sharp and broad attention.

- *Parallel processing* – allowing an individual to attend to materials in two different modalities simultaneously.

- *Not a zero-sum game* – cognitive capacity can be drawn from other activities at moments of need and concentrate it more completely on perception of the current sensory information.

- *Selectivity* – perceiving some aspects of the current sensory information while ignoring others.

The area of selective perception is also approached by Timmermans (1993). Increasing the task complexity (determined by the number of alternatives and the number of attributes relating to a choice) in a multi-attribute decision experiment caused respondents to implement screening processes to the information presented to them. This study is supported by Payne et al (1992), who suggest that the number of alternatives in a choice, produces the greatest influence in information screening.

Perception is also influenced by the way in which information is presented to an individual – and this is referred to as sensory modality (McGuire, 1978; Cornsweet, 1970). This research focuses on how different modes of information affect attention levels and suggests that different modes may cause individuals to attend to the information at differing levels. Using the assumption of rationality within the analysis of stated preference response data, practitioners commonly assume that respondents use all the information presented to them within a choice scenario. However, the existence of selective perceptive by respondents, and the impact of differing attribute representations on perceptions, could impact on the information set used by respondents in their choice process. In addition, the choice strategy employed by a respondent (discussed in the next section) can also impact on the information used by a respondent to reach a response. The impact of these influences on the choice process and on the analysis of stated preference response data are discussed in section 2.2.5.

The next section considers how respondents evaluate the perceived information presented to them, within their choice process, using different choice strategies, or decision rules.

2.2.5 Choice Strategies

Solomon (2002) categorises the different ways that respondents evaluate information within a choice scenario into two types: compensatory and non-compensatory choice strategies (termed by Solomon as decision rules). Compensatory, or utility maximising choice strategies are those where respondents evaluate the utility associated with all the different attributes associated with a product or service. The individual is considered to reach an overall assessment by trading off attributes against each other. This type of choice strategy is assumed within the rational theory of choice (as described in section 1.2.1).

The key to the alternative theory of rationality, the procedural theory, is that individuals use 'rules of thumb' - simple procedures - to guide their actions. These are what Solomon (2002) describes as non-compensatory choice strategies. Simon (1978) treats the use of such procedures as short-cut devices for an individual's decision-making. In 1990 Simon summarised that *'because of the limits of their computing speeds and power, intelligent systems must use approximate methods to handle most tasks. Their rationality is bounded'*. For example, Hargreaves Heap et al (1992) suggest an individual may use adaptive expectations, a simple examination of the past to determine the future, rather than collect all the information that might allow the formation of a rational expectation. Similarly, an individual who is deciding on which investment projects to undertake may use a simple rule of thumb such as 'undertake any project with a payback period of less than three years', rather than carry out a strict ranking of projects according to the present discounted value of their expected profits. Simon suggests that procedural rationality is really an artificial form of instrumental rationality. Individuals still wish to motivate their utility. However their rationality has become bounded because they are not fully informed – in these circumstances, people settle for satisficing rather than optimising.

The existence of bounded rationality has resulted in decision processes that do not conform to the utility maximising compensatory processes that are assumed to be adopted by respondents within stated preferences experiments. A number of alternative decision making strategies, based on the heuristic search paradigm, are provided by Ampt et al. (1995):

- *Utility maximising choice strategies* are those usually assumed by stated preference practitioners. This means that respondents are believed to attach weightings to each/all of the attributes in a choice situation. It is assumed that the option with the highest total utility will therefore be chosen.

- *Dominance-based choice processes* are those where people select an option that is valued higher than all other alternatives on each attribute. For example, for the choice scenarios presented during the stated preference experiments during this research, an individual would identify which vehicle was preferred, when valuing the choice based on only one of the attributes at a time. Which vehicle has the preferred appearance? Which vehicle has the preferred price? This would continue for all attributes presented within the choice scenario.

This kind of choice strategy would clearly be likely not produce a single solution.

- *Maximax* and *maximin* choice strategies. People who use a maximin choice strategy identify the attribute that has the greatest negative impact upon the their total utility evaluation, and then choose the alternative that has the highest level of satisfaction (utility). People using a maximax strategy identify the attribute that has the greatest positive impact on a total utility evaluation and then chooses the option that provides the highest level of satisfaction (utility) from this attribute. This would not necessarily produce a single solution.

- *Lexicographic choice strategies* are those used when a person hierarchically orders all the attributes of choices they are about to make into the order that has the most influence upon their total utility evaluation, and then chooses the alternative with the highest value on the most important attribute. Here travel choices of this type are easy to find, for example the person for whom travel time is critical will choose the quickest journey over all other attributes.

- *Conjunctive choice strategies* are those made when a person rejects any alternative that fails to meet anyone of the minimum criterion of acceptability. This means that the individual sets an acceptable level for each attribute and rejects any alternative where the level/levels are not met. Conversely *disjunctive* choice strategies result in the acceptance of any alternative exceeding a certain criterion. Again this will not always give a single solution.

The next section considers how the type of decision can impact of the choice process of respondents – affecting the information search, the perception of available information, and the choice strategy adopted by individuals. These are discussed in terms of the level of effort employed by the respondent in the decision-making process.

2.2.6 Consumer Decisions, Effort and Consumer Involvement

Previous sections have highlighted a contrast in terms of the different assumptions that can be made about the way individuals make decisions. In economic models, individuals are assumed to act 'rationally' and maximise their utility from a choice. In psychology, research suggests that individual's rationality becomes bounded, and that problem solving becomes simplified by using rules known as heuristics (as described in detail in the previous section).

Solomon (2002) suggests that the level of effort that is employed by the decision maker corresponds to the type of decision that an individual is making. He presents a continuum of decision-making, which has extremes of habitual (or routine) decision-making at one end, and extended problem solving at the other end, which corresponds to choices about different types of product (Appendix C). Similarly, many researchers within the field of marketing and decision research have related the level of consumer involvement with a product choice, and the type of decision process that

is employed (Foxall, 1990; Eysenck and Keane, 2001; Mittal, 1989). Foxall (1990) suggests that the level of consumer involvement relates to a product's complexity, risk, and cost. A product that Foxall highlights as typically exhibiting high consumer involvement is that of a car. In contrast the purchase of baked beans for example, is usually considered a low involvement decision. Consumer involvement can be considered to be consumers' motivational state towards a product (Mittal, 1989).

Swanson (1998) discusses the level of motivation of subjects within stated preference experiments to undertake complex decision-making. He states:

> *'The tasks subjects are asked to undertake may be complex and require substantial mental effort, so why should we believe that they will apply the necessary effort in the 'laboratory' where there may be little to lose, unlike real life situations where there may be very real consequences to their choices'*

As a hypothetical choice presents a low risk decision, and respondents have little motivation to undertake extensive problem solving behaviour, it seems likely that respondents might employ non-compensatory (non-utility maximising) choice strategies in order to reach their choice. The following section considers the implications of this possibility in terms of the research questions presented within this thesis.

2.2.7 Summary of the Literature Relating to Research Questions 1 and 2

The first research question aims to identify the choice strategies employed by a respondent during a stated preference experiment. Section 2.2.5 suggested that a number of different choice strategies, that differ from the utility maximising choice strategy commonly assumed by stated preference researchers, are used by consumers in their decision making. The previous section described how the type of decision being made by an individual is likely to affect the type of choice strategy used in a decision process. As the hypothetical choice scenarios presented within a stated preference experiment present a low risk decision, and respondents have little motivation to undertake extensive problem solving behaviour, it seems likely that respondents might employ non-compensatory (non-utility maximising) choice strategies in order to reach their choice

The second research question considers how the way in which attributes are represented to a respondent in a stated preference experiment affects the choice strategy used in the decision process. Section 2.2.3 suggested that respondents' perception of information may be affected by the modality in which it is presented. Furthermore, chapter 1 presented evidence within the field of stated preference research that the way in which responses are represented affects the choice process of respondents (Nelson, 1995,1998).

2.3 The Impact of Alternative Choice Strategies on the Estimation of Consumer Utility Models (Research Question 3)

The third research question considers the impact of the choice strategy employed by respondents on the estimation of consumer utility models. Ampt et al. (1995) questions the realism of the assumptions used in stated preference techniques relating to the choice strategies used by respondents. This kind of criticism has previously been discussed at length about economic theory in general. Blaug (1980) suggests that 'realistic' assumptions in the social sciences can be considered as *'motives to economic actors that we, fellow human beings find comprehensible'*. Blaug states that the Verstehen doctrine tells us that this is a *'desideratum of adequate theorizing in the social sciences'*. Friedman (1953) in his Essay on the Methodology of Positive Economics, when discussing the Maximization of Returns Hypothesis suggests that *'individuals behave as-if they were seeking rationally to maximise their expected returns... and have full knowledge of the data needed to succeed in this attempt'*. Blaug (1980) compares this with the hypothesis that *'billiards players calculate the angle of the momentum of billiards balls every time they drive the ball into the pocket'*. The billiards player may act in a way that suggests that this calculation occurs – this does not mean that this process does actually occur. Theories are only instruments for making predictions or, better still, inference tickets that warrant the predictions that we make (Coddington, 1972: Blaug, 1980).

The suggestion by Friedman that the assumptions that are made about behaviour do not need to be realistic, so long as they allow accurate predictions, appears sensible. In the context of the impact on the estimation of utility models of analysing responses made by non-utility maximising choice strategies *(research question 3)*, this would suggest that as long as the analytical techniques employed enabled the estimation of utility models that exhibit predictive validity, they could be deemed an appropriate approximation.

A number of studies have suggested that linear compensatory models do seem to perform well at reproducing choices (Foerster, 1979; Green and Srivinsen, 1978; Caroll and Johnson, 1990; Armstrong, 1985; Williams and Ortuzar, 1982). The impact of the use of non-compensatory choice models on the predictive abilities of stated preference experiments are reported by Green and Srinivasan (1978), who state:

> *'for predictive validity the problem is not as serious as it may seem. This is because the compensatory model of conjoint analysis can approximate the outcomes of other kinds of decision rules quite closely'*

This appears to support the suggestion by Friedman above that assumptions that are made about behaviour do not need to be realistic, so long as they allow accurate predictions. In entering into this discussion, Swanson (1998) suggests:

> *'...several researchers had shown that linear additive models could reproduce choice very well under a variety of choice making strategies. At first sight, that might suggest that we need not worry about what strategies used if the same model format can capture results of all them well enough'.*

However, Swanson (1998) warns of the use of compensatory choice models as an approximation of non-compensatory choice strategies used by respondents. He states that this type of approximation is particularly problematic when an estimated model is used to examine ratios, and in addition the choice context includes a 'dummy variable'. A dummy variable would for example, represent the presence or absence of a variable. Swanson suggests that non-compensatory methods of choice by individuals could result in incorrect implied monetary values of the dummy variable. Given that the use of dummy variables within choice models is commonplace, this is an important implication of the use of alternative, non-compensatory choice strategies by respondents.

The third research question presented in this research aims to address the impact of identified choice strategies used by stated preference respondents on the estimated utility models.

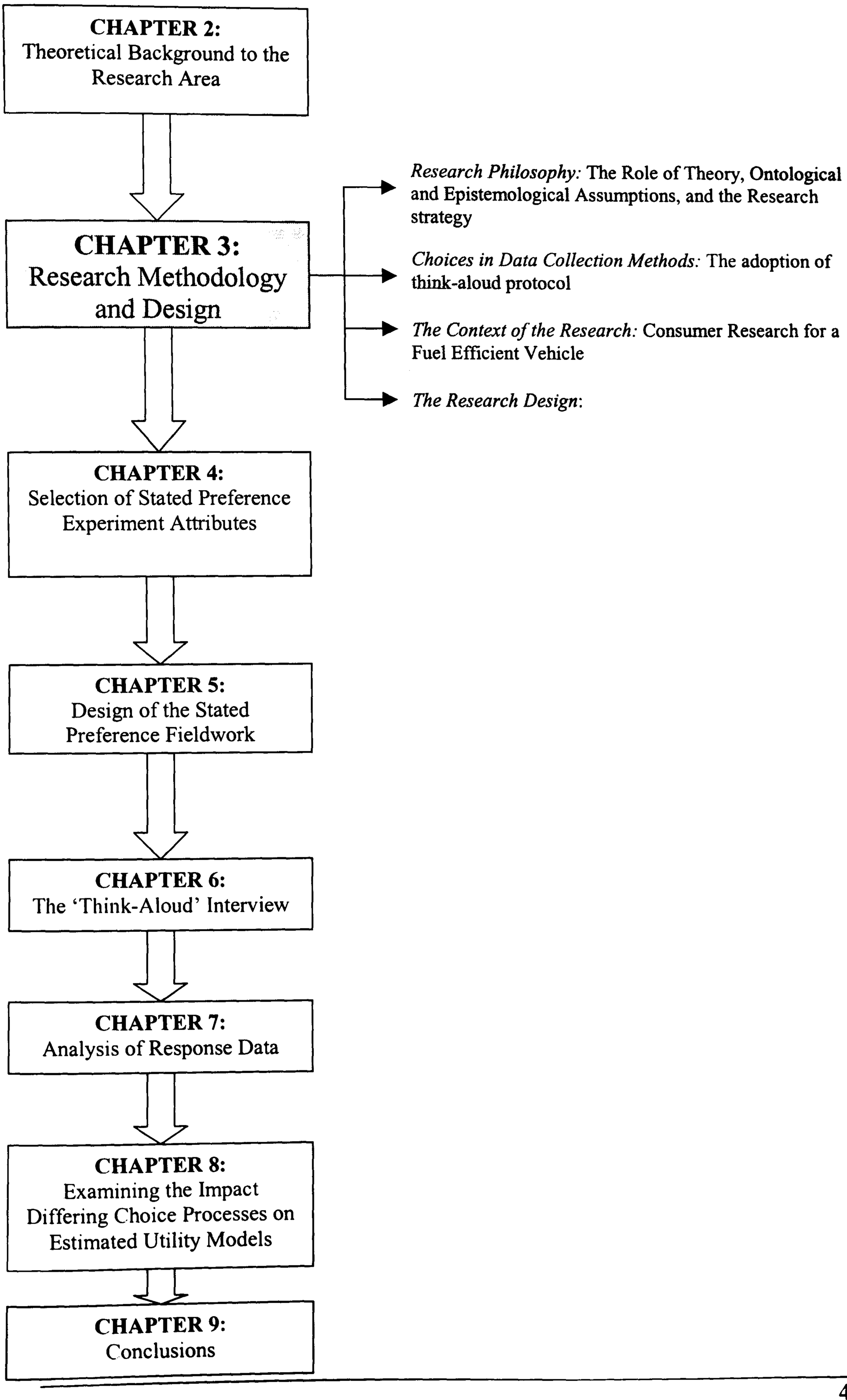
2.4 Conclusions

This chapter has outlined the axioms of the rational choice model presented within the field of economics, and has highlighted attempts within the field to explain contradictions to these axioms that have been identified in observed behaviour. Literature within the field of psychology has also been discussed that identifies contradictions in terms of the bounded rationality in which respondents must make decisions.

Evidence from literature that the type of choices made by respondents in stated preference experiments (low risk, and low motivation), are likely to result in choices that deviate from the economic concept of rational choice were discussed, which supports the research questions that are to be addressed in this research.

The next chapter presented in this thesis, considers alternative methodological choices considered to address the research questions, before presenting the chosen methods employed in this research.

CHAPTER 3: RESEARCH METHODOLOGY AND DESIGN


CHAPTER 2:
Theoretical Background to the Research Area
CHAPTER 3:
Research Methodology and Design
Research Philosophy: The Role of Theory, Ontological and Epistemological Assumptions, and the Research strategy
Choices in Data Collection Methods: The adoption of think-aloud protocol
The Context of the Research: Consumer Research for a Fuel Efficient Vehicle
The Research Design:
CHAPTER 4:
Selection of Stated Preference Experiment Attributes
CHAPTER 5:
Design of the Stated Preference Fieldwork
CHAPTER 6:
The 'Think-Aloud' Interview
CHAPTER 7:
Analysis of Response Data
CHAPTER 8:
Examining the Impact Differing Choice Processes on Estimated Utility Models
CHAPTER 9:
Conclusions

3.1 Introduction

This chapter identifies the research design and methodology employed to address the research questions. The research questions for this thesis were first introduced at the end of chapter 1, and further explained in chapter 2, where they are positioned within literature relating to individual choice. To reiterate, the research questions are:

1. What choice strategy is used for each choice scenario presented to the respondent during a stated preference experiment?

2. Does the way attributes are represented, using picture or text, affect the choice strategy employed by a respondent during a stated preference experiment?

3. Does the choice strategy employed by respondents during stated preference experiments affect the estimated utility models, and resulting utility estimates?

The methodology that addresses these research questions is described in a number of stages. The first stage (section 3.2) presented in this chapter frames the research design by presenting the philosophical position adopted in this thesis. The research questions addressed within this research design are related to the role of theory, and the adoption of a *deductive* research approach is explained. The research philosophy is then explained in terms of the ontological position of the research (which defines what can be known about the respondents' decision-making processes), and the epistemological position (how these processes can be observed by a researcher).

The chapter then defines the research approach adopted to address the research questions stated above. This refers to the choice of research style adopted by the research rather than a detailed breakdown of the research methods used to collect data.

The second stage of the chapter (section 3.3) then describes the requirements of the data collection method used within this research. These requirements are then used to evaluate alternative data collection methods that could be used to address the research questions presented above.

The third stage of the research design (section 3.4) describes the requirements of an appropriate research context within which the research can be implemented. This section describes how the adopted context, consumer research for a new vehicle design, meets the requirements of this research context.

Finally, the fourth stage of the chapter (section 3.5) clearly identifies the steps in the adopted research design, and how this will be implemented within the defined context of the research. The steps in the research design are then linked to further explanatory chapters on the different stages in the data collection and analysis.

3.2 Research Philosophy

Research philosophy describes the way in which one thinks about the development of knowledge. Saunders et al. (2000) highlight the importance of understanding the philosophical underpinnings of a research design. They state:

> *'This [research philosophy] sounds rather profound, and not something about which you would normally give much thought. Yet the way we think about the development of knowledge affects, albeit unwittingly, the way we go about doing research'*

Section 3.2.1 considers how the research questions relate to the role of theory, by testing the assumptions relating to the theory of choice adopted by stated preference researchers, and testing the possible relationship between the representation of attributes in stated preference experiments, and the way in which respondents use these presented attributes to make their decisions. Section 3.2.2 then presents that ontological and epistemological stances adopted in this thesis, and how this relates to the research questions. Section 3.2.3 then considers that research approach adopted by this research, and considers choices between alternative types of research style.

3.2.1 Alternative Research Approaches and the Role of Theory

Phillips and Pugh (1994) make a clear distinction between what is *research* and what they term *intelligence gathering*. Saunders et al. (2000) suggest that intelligence gathering is simply the *'gathering of facts'*, whilst research is explanatory and leads to the development of theory. Gill and Johnson (1997) define theory as *'a formulation regarding the cause and effect relationships between two or more variables, which may or may not have been tested'*. When presenting the methodology for this research it is therefore useful to explain how the role of theory fits within the research design. Gill and Johnson (1997) ask: *'what are the sources of such theories and hypotheses, and how do we set about judging rigorously whether or not these theories and hypotheses are true?'*. They suggest that different answers to these questions allow the distinction between *inductive* and *deductive* research approaches to be made. The role of theory, and the research strategy adopted for this research are presented in this section.

In order to explain the distinction between inductive and deductive approaches, it is useful to introduce Kolb's experiential learning cycle, shown in figure 3 (Kolb, Rubin and McIntyre, 1979).

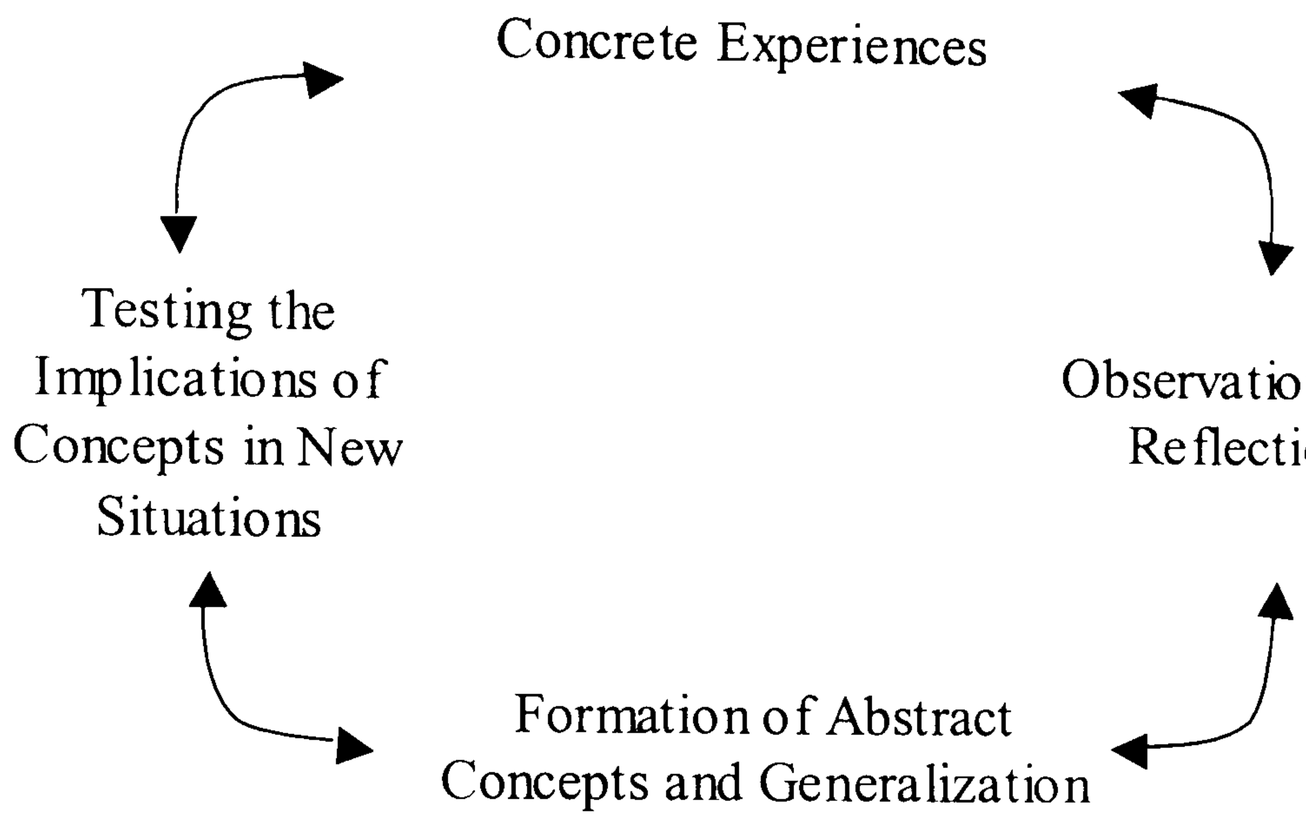


Figure 3: Kolb's Experiential Learning Cycle (Kolb, Rubin and McIntyre, 1979)

Kolb suggests that learning might start with the observation of an event or stimulus, which the individual then reflects upon to make sense of it. This might lead to the formulation of an explanation for what has happened, producing abstract concepts and generalisations. This is the inductive approach. Blaikie (2000) suggests that to make a scientific discovery, pure *inductive* strategy requires:

> *'meticulous and objective observation and measurement, and the careful and accurate analysis of data... ...General laws are produced by applying inductive logic to the carefully accumulated observations and experimental results.'*

Blaikie continues by categorising the inductive approach into four stages:

1. All facts are observed and recorded without the selection or guesses as to their relative importance.
2. These facts are analysed, compared and classified, without using hypotheses.
3. From the analysis, generalisations are inductively drawn as to relations between the facts.
4. These generalisations are subjected to further testing.

Blaikie (2000) highlights some major criticisms of these stages in the inductive approach. In particular he questions:

- That preconceptions can be set aside to produce objective observations
- That 'relevant' observations can be made without some ideas to guide them

As an alternative to the inductive approach, learning can start at a point where the rule explanation is received by the learner from others, and is subsequently tested out by the learner (Kolb, Rubin and McIntyre, 1979). This is the deductive approach, and

is represented by the left-hand side of Kolb's diagram (figure 3) – beginning with abstract conceptualisation, and then moving on to test through the application of theory. Gill and Johnson (1997) state that *'a deductive research method entails the development of a conceptual and theoretical structure prior to its testing through empirical observation'*. This strategy, also known as hypothetical-deductive, or falsificationism suggests that:

> *'Instead of looking for confirmation evidence to support an emerging generalisation, as occurs in the inductive research strategy (known as 'justificationism'), Popper argued that the aim of science is to try and refute the tentative theories that have been proposed.'* (Blaikie, 2000)

This strategy is described by Robson (1993) in a series of 5 sequential steps:

1. Deducing a hypothesis (a testable proposition about the relationship between two or more events or concepts) from the theory.
2. Expressing the hypothesis in operational terms (i.e. ones indicating exactly how the variables are to be measured), which propose a relationship between two specific variables.
3. Testing this operational hypothesis. This will involve an experiment or some other form of empirical enquiry.
4. Examining the specific outcome of the inquiry. It will either tend to confirm the theory or indicate the need for its modification.
5. If necessary, modifying the theory in the light of the findings. An attempt is then made to verify the revised theory by going back to the first step and repeating the whole cycle.

Drawing from evidence from the field of psychology, this research queries some of the traditional assumptions made by stated preference researchers about the way respondents use information during the stated preference experiment. The research questions (presented in section 3.1 of this chapter) identify a hypothetical link between the representation of attributes within a stated preference experiment and the choice process adopted by the respondent, and also suggest a relationship between the choice process adopted by respondents within stated preference experiments and the estimated utility models developed from individuals responses made using these choice processes. Clearly then, this research follows the deductive approach described earlier where a possible relationship between variables is identified, and is to be tested within the research process.

The following section now considers the ontological and epistemological assumptions related to the research presented within this thesis. These assumptions influence the choice in research methods used to implement the deductive research described in this section.

3.2.2 *Ontological and Epistemological Assumptions Relating to the Research Design*

The field of research philosophy is extremely large, and there are many different approaches that a researcher may adopt within their research. Most texts examining this subject therefore begin by providing an overview of the issues relating to two extreme philosophical positions that may be held, as an introduction to the subject area. Easterby Smith et al. (1991) and Saunders et al (2000) compare Positivism and Phenomenology. Similarly, Blaikie (2000) and Denzil and Lincoln (1994, 2000) contrast the positions of Positivism and Constructivism. Whilst taking this approach themselves, Easterby Smith et al. (1991) do highlight the problems with describing the field in terms of these contrasting views:

> *'Each of these positions has to some extent been elevated into a stereotype, often by the opposing side. Although it is now possible to draw up comprehensive lists of assumptions and methodological implications associated with each position, it is not possible to identify any one philosopher who ascribes to all aspects of one particular view'.*

Whilst finding examples of the application of these stereotypical extreme positions within the area of research philosophy is therefore problematic, it is useful to examine the questions that they raise, before discussing the position of the chosen research philosophy of this research. The philosophical positions of Positivism and Phenomenology are therefore compared here. These philosophical paradigms can be described in terms of *ontology*, and *epistemology*.

The ontology question relates to *'what is the form and nature of social reality and what is there that can be known about it?'* (Denzil and Lincoln, 1994). Within the context of the decision making process of respondents during stated preference experiments, the ontology question relates to the nature of the respondents' decision making processes. The ontology of the postivist position is often associated with the pure sciences. For example, Remenyi et al. (1998) suggests that the positivist researcher prefers *'working with an observable social reality and that the end product of such research can be law-like generalisations similar to those produced by the physical and natural sciences'*. The positivist paradigm holds that social reality is fully observable – that is, that observed events are driven by natural laws and mechanisms. At the other extreme constructivism holds that:

> *'realities are apprehendable in the form of multiple, intangible mental constructions, socially and experimentally based, local and specific in nature, and dependent for their form and content on the individual persons or groups holding the constructions'* (Denzil and Lincoln, 1994).

Therefore social reality is considered to be created by individuals themselves within society. This leads to the possibility of multiple co-existing social realities. The ontological position held within this research is closer to the positivist end of the spectrum. Whilst consumer decision-making is considered to be an internal cognitive process, it is considered possible that this process can be elicited from individuals –

and that these processes are part of a complex natural mechanism. However the ability to elicit these processes from individuals is considered to be dependent upon the choice of appropriate research methods. The choice of what is considered to be *appropriate* research methods is strongly related to the epistemology adopted within the research strategy.

The epistemological question relates to what is the nature of the relationship between the *'knower or would be knower and what can be known?'* (Denzil and Lincoln, 1994). It relates therefore to how a researcher gathers information about social reality, and what is considered to be knowledge. Within the context of the decision making process of stated preference respondents within this research, the epistemological question therefore relates to how a researcher is believed to be able to uncover part or all of these internal mental decision processes. Whilst there is some variation in the epistemological position of the different approaches at the positivist end of the spectrum, there is general agreement that it is possible to observe reality in some way. The Positivist assumption is that *'the researcher is independent of and neither affects nor is affected by the subject of the research'* (Remenyi et al, 1998). In contrast, the Constructivist position assumes that the investigator and the investigated object are interactively linked with the values of the investigator inevitably influencing the enquiry. Constructivists believe that *'findings are therefore value mediated'* (Denzin and Lincoln, 1994). Put simply, a positivist believes it is possible to observe reality from a detached position, whilst constructivism learns about the social reality from within it. This research takes the position that a detached researcher position is desirable. Within the context of this research, this means that it is considered desirable that the decision-making process identified as being used by respondents within a stated preference experiment, can be elicited without the process itself being influenced by the researcher. However whilst this position is considered desirable, it is believed inevitable that the research is influenced by the researcher, at least to a small degree, in several possible ways:

- Through interaction between the researcher and the research subjects
- Through the interpretation of the information elicited by the research subjects by the researcher.

The ontological and epistemological positions assumed within this research are most closely described by the post-positivist position of philosophy as defined by Denzil and Lincoln (1994, 2000). As is the attribute in the pure sciences, it is believed that there exists a 'real reality'. However, unlike the positivist position it is understood that this may not be perfectly apprehended by a researcher. The epistemology adopted here is that it is deemed desirable that the researcher should *aim* to achieve objectivist detachment from the research. This influences therefore the design of the research, which aims to limit the level of influence and interpretation of the researcher on the identification of individuals' decision-making processes within stated preference techniques.

The following section describes the research approach identified for implementing the deductive research addressing the questions presented within this thesis. The research approach adopted for this research is heavily influenced by the philosophical assumptions described within this section.

3.2.3 The Adopted Research Strategy

This section describes the alternative research strategies available to the social science researcher. The term research strategy here refers to the style of the research that is adopted rather than detailed breakdown of the data collection methods and analysis employed. These will be discussed later in the thesis.

Saunders et al. (2001) present examples of research strategies that are available to the researcher, for use on their own or in combination. They describe the use of:

- Experiment
- Survey
- Case study
- Grounded theory
- Action research
- Cross sectional and longitudinal studies

In this research, an experiment was considered the most appropriate research strategy. Use of experiments is most closely associated with the pure sciences although Saunders et al (2001) state that experiment *'features strongly in much social science research, particularly psychology'.*

An experimental approach within this research aims to identify the choice strategies used by respondents in response to differing methods of attribute representation within stated preference experiments *(research questions 1 and 2).* Furthermore, an experiment was considered an appropriate method of identifying how the use of differing choice strategies impacts on the estimation of utility models, and the resulting utility estimates *(research question 3).*

This adopted research strategy fits closely with the philosophical assumptions presented within the previous sections.

- An experiment fits closely with the concept of a deductive approach (which section 3.2.1 defined this research as being an example of), where a theoretical relationship is examined within the research.
- An experiment is aligned with the aim to achieve an objective, detached role for the researcher, which was described as one of the epistemological assumptions within this research (as described in section 3.2.2).

The following section considers the types of data collection methods that are most appropriate for this research, within the design of an experiment. A more detailed discussion of the requirements and available choices in the design of the experiment to be used within this research will be presented in the next section (section 3.3) before a more detailed description of the research design implemented is provided (section 3.5)

3.2.4 The Data Collection Methods

This section considers the alterative types of data collection methods that might be employed within the context of the experiment to be employed within this research. A common dichotomy is made between research methods that are available to the researcher – a distinction being made between *quantitative* and *qualitative* methods (for example, Easterby-Smith et al., 1991; Bryman, 1988; Saunders et al. (2000) suggests that attempts to define the differences between quantitative and qualitative *methods* can be problematic. They suggest however that it is easier to make a distinction between the *data* produced from the different types of research. Table 1 provides Saunders et al.' distinction between the two types of data.

Quantitative Data	**Qualitative Data**
• Based on meanings derived from numbers • Collection results in numerical and standardised data • Analysis conducted through the use of diagrams and statistics	• Based on meanings from words • Collection in non-standardised data requiring classification into categories • Analysis conducted through the use of conceptualisation

Table 1: Distinctions between quantitative and qualitative data (Saunders et al, 2000)

Despite this commonly quoted dichotomy of data collection methods, much research makes use of a combination of methods. Blaikie (2000) states:

> *'Almost all data used by social researchers begins in a qualitative form. It is only after work has been done on it, to transpose words into numbers, that quantitative data come into being... ...Quantitative studies may collect some data in words (e.g. they use open-ended questions in a survey, or use text on which data will be transformed into a numerical form. Similarly some qualitative studies may produce simple tables of frequencies and percentages to summarise some features of non-numerical data'.*

Clearly much research makes use of both quantitative and qualitative techniques. Whilst a qualitative data collection technique may be adopted, it might be appropriate for quantitative technique to be used during the analysis of the data. This is considered the appropriate approach for the research design used within this research.

Chapter 1 highlighted research carried out by Nelson and Towriss (1995) that found that differences between verbal and visual representation of attributes in stated preference experiments affected the responses made by respondents. However, the quantitative experimental data collection methods implemented within the research design meant that the underlying reasons for the differences in responses could not be explained by individuals underlying use of information during the experiment. In the previous section, it was explained that this research also adopts the use of an experiment, to test alternative stated preference designs (attributes representation types). However, in contrast to the work carried out by Nelson and Towriss (1995) it

is considered appropriate within this research, that a qualitative data collection technique is used in order to fully expose a respondent's cognitive processing of information during a stated preference experiment.

Kant based the existence of cognitive processes as a justification for the usage of qualitative research methods. Hamilton (1994) describes the argument presented by Kant:

> *'Kant proposed, in effect, that perception is more than seeing. Human perception derives not only from the evidence of the senses but also from the mental apparatus that serves to organise the incoming sense impressions... Human knowledge is ultimately based on understanding, an intellectual state that is more than a consequence of experience. Thus for Kant, human claims about nature cannot be independent of inside-the-head processes of the knowing subject... such inside the head processes are totally at variance with Cartesian [quantitative] objectivism.'*

Similarly, this argument supports the use of qualitative data collection techniques as the most appropriate methods for the examination of the cognitive processes that are of interest in this research.

The following section considers in more detail the use of alternative qualitative data collection methods, within the context of an experiment that tests alternative stated preference designs.

3.3 Choices in Data Collection Methods

3.3.1 Research Method Requirements

Before discussing alternative methods available, it is useful to first present the requirements of the data collection method for this research. The most important criteria for any data collection methods is that they are able to address the aims of the research, that is the research questions presented in section 3.1 of this chapter. It is necessary therefore to firstly identify the data requirements needed to meet the research questions, before appropriate data collection methods can be identified. These data requirements are as follows:

- The identification of the choice strategies used by respondents during a stated preference experiment *(research question 1)*, and the relationship of these identified choice strategies to the way that the attributes included with the experiment are represented *(research question 2)*.

- The responses made by individuals within a stated preference experiment, as a result of the identified choice processes are also required, in order to be able to estimate associated utility models. This will allow the comparison of any differences between the utility models estimated for different sample groups

as a result of differences in the choice strategies used by respondents *(research question 3)*.

In order to be able to identify the choice strategies used by respondent within a stated preference experiment, it is considered necessary that data collection be carried out during or after the implementation of such an experiment. To identify the choice strategy used by a respondent to make a response for a particular choice scenario, it is necessary that the respondent has actually undertaken this task. Furthermore, stated preference experiments rely upon decisions made about *repeated hypothetical choices* and it is considered appropriate that respondents within this research are asked to respond to repeated hypothetical choices also. Previous research carried out by Green and Srivinsen (1978), examining the choice strategies used by respondents during *ranking* stated preference experiments suggest that respondents changed their choice strategy during the experiment. The use of a full *choice based* stated preference experiment as the context of this research will enable the identification of changes in the choice strategies used by respondents for each additional scenario within a *choice-based* stated preference experiment.

Another requirement of the data collection method employed within this research is its ability to limit the level of research bias that could influence the output of the research. The importance of a detached objective role for the researcher was emphasised in the discussion of the epistemological assumptions adopted within this research presented in section 3.2.2.

The following sections describe alternative qualitative data collection methods available, and their suitability for this research, in light of the requirements outlined above. The alternative methods considered are:

- Interviews
- Self Reports
- Think-aloud (verbal protocol)

3.3.2 Interviews

A research interview is a general terms that refers to a number of different types of interview. Interviews can vary from the highly structured and formal, to the unstructured and informal. Saunders et al. (2000) categorise different types of interview as: structured interviews; semi-structured interviews; and unstructured interviews. Similarly, Healey and Rawlinson (1993) describe interviews as either standardised interviews or non-standardised interviews.

- ***Structured interviews*** are based on sets of standardised questions. Sanders et al. (2000) suggest that:

  'while there is social interaction between you and the respondent, such explanations which you will need to provide, you should read out the questions in the same tone of voice so that you do not indicate any bias'.

- ***Semi-structured interviews*** are non-standardised, although the researcher will have a list of themes and questions to be covered – that may vary from interview to interview (Sanders et al., 2000).

- ***Unstructured interviews*** are described by Saunders et al (2000), as informal interviews. They use no predetermined list of questions.

Within the context of this research, interviews might be used during or after a respondent has undertaken a stated preference experiment. Respondents could be asked standardised questions (structured interviews), non-standardised questions (semi-structured interviews), or be directed in a non-standardised, informal discussion (unstructured interview) about the way they used the information presented to them during the stated preference experiment to reach a decision. This research requires the identification of a choice *process*, and it is therefore considered more appropriate to use non-standardised interview methods that provides *'the opportunity to talk freely about events, behaviour and attributes in relation to the topic area'* (Saunders et al., 2000). Structured interview techniques are considered more likely to influence, or interrupt the elicitation of the process being described by the respondent.

The following section considers the use of an unstructured interview technique – self reports, which are a commonly used method within decision research.

3.3.3 Self Reports

Self-report is a commonly used method for understanding decision making processes. These methods represent *'natural or implicit methods because they have everyday commonsensical origins or uses'* (Carroll and Johnson, 1990). Argyris (1976) however emphasises that:

> *'we must distinguish between espoused theories consisting of the goals, assumptions and values that people claim to guide their decisions from the theories-in-use that are the actual guides to decisions'.*

Caroll and Johnson (1990) also express their reservations about the self-report method because *'decision makers frequently are unable to articulate their underlying decision process or are more interested in presenting a favourable impression'*. They identify three main threats to the usefulness of self-reports:

- In the process of *remembering* what they did in any specific instance, they may have forgotten parts of the decision.

- They may be *reconstructing* the decision process by using what they usually do or what they are supposed to do, rather than report what they actually did.

- They may be *rationalising* by creating a logical story or saying what they think the audience wants to hear, instead of the truth.

Ericsson and Simon (1984) suggest that *'the accuracy of verbal reports depends upon the procedures used to elicit them and the relation between the requested information and the actual sequence of heeded information'*. Improving the accuracy of self-report methods can be achieved by:

- Ensuring that the self-report is elicited as close as possible in time to the experience they are recollecting (Caroll and Johnson, 1990).

- For the original event/experience being recollected to have established a strong memory by being important, attracting conscious attention, or being repeated (Ericsson and Simon, 1984).

Whilst self reports meet the requirements of this research in terms of maintaining the context of a stated preference experiment, it is uncertain whether this method would enable the researcher to elicit accurately the information set used by a respondent, and the choice strategy adopted in the decision making process. Whilst the described steps above could be implemented to improve the accuracy of the reports, it is considered unlikely that respondents could recall accurately a process that is difficult to define.

The following section discusses an alternative qualitative data collection method, which whilst also maintaining the context of a stated preference experiment, also removes the problems associated with respondents providing inaccurate recall of past actions.

3.3.4 Think Aloud (Verbal) Protocol

Caroll and Johnson (1990) suggest that the most *'common and historically important process-tracing method'* within the field of decision research is that of the 'think-aloud' protocol (also known as verbal protocol). Think-aloud protocol refers (as it sounds) to the simple method of asking respondents to say out loud what they are thinking. This method originates from the nineteenth century when researchers asked participants that were highly trained in psychology, to use a method of introspection to increase their understanding of cognitive processes. This research however, fell out of favour by the 1920s, with the rise of the behaviourist paradigm (Carol and Johnson, 1990). However the think-aloud protocol developed by Newell and Simon (1972) differs significantly from the earlier introspection methods used by researchers, in that it does not ask respondents to theorise about what or how they are thinking.

In order to provide the reader with a greater understanding of how verbal protocol is used, it is useful to describe a previous application of the method. Payne et al. (1978) studied the mental processes of respondents choosing between alternative hypothetical apartments. Respondents were asked to select information about these apartments from a set of envelopes arranged in rows and columns by alternatives and attributes.

After the initial collection of verbal protocols, the data was coded. Table 2 below shows an extract of a coded protocol.

Statement	Code
Let's just see what the rents are in the apartments first.	GOAL
The rent of A is $140	READ (A, Rent)
The rent of B is $110	READ (B. Rent)
The rent of C is $170	READ (C. Rent)
Um, $170 is too much	ELIMINATE (C)
(.....)	
I'm going to look at landlord attitude.	GOAL
In H it's fair	READ (H. Landlord Attitude)
(.....)	

Table 2: A Coded Verbal Protocol of Apartment Search (Payne et al., 1978)

Caroll and Johnson (1990) suggest that '*as our understanding of the decision process develops we can build explicit models of the task'*. This could be '*represented in a flow chart that's shows the sequence in which operations occur, and the information flowing in and out of each operation*'.

Think-aloud protocol seems to lend itself well to research in the area of this thesis. The method has been used previously to understand mental processes in decision-making. Previous research, in particular research discussed in chapter 2 by Payne et al (1978) and Timmermans (1993) used the method - successfully identifying the choice strategies and the information used by consumers in their decision making process. Verbal Protocol is also considered appropriate for use in this research as to allow the choice strategies of respondents to be identified within the hypothetical choice scenarios of a stated preference experiment. Respondents simply *'think-aloud'* whilst carrying out the experiment.

This research aims to limit the level of researcher bias. The design of any stated preference experiment to provide the context to this research would clearly be determined by the researcher, and would in this respect be biased towards meeting the aims of the research. The data collected through the use of the verbal protocol method would however provide data in the respondent's own language and descriptions (uninfluenced by the researcher other than for the initial instructions describing the exercise to the respondent). A clear analytical framework, developed before the data collection was implemented, also aimed to reduce the level of researcher bias during the analysis of the data.

Given the ability of this method to meet the aims of this research (as highlighted through previous application in related studies), the capacity for the method to be employed within the context of a stated preference experiment, and the relative limitation of researcher bias, this method is deemed appropriate for addressing the research questions presented in section 3.1.

The importance of eliciting information from respondents within the context of a stated preference experiment have been emphasised in section 3.3.1. The

requirements of the context for this stated preference experiment is discussed in the following section.

3.4 The Context for the Stated Preference Experiment

3.4.1 Requirements of the Research Context

The think-aloud protocol (described in section 3.3.4) adopted for this research is implemented whilst a respondent is taking part in a stated preference experiment. It is necessary therefore that a stated preference experiment be designed. This experiment requires an appropriate research context.

Three factors were considered in the requirements for the context of the stated preference experiment: the level of consumer involvement in the purchasing decision of interest, the ease of implementation, and the potential provision of a further contribution to knowledge.

- **The level of consumer involvement:** Section 2.2.6 described how the level of consumer involvement has been considered to affect the level of motivation a consumer has to participate in the full information processing sequence within the decision making process (Foxall 1990, 1993; Mittal, 1989). Foxall (1993) suggests that the level of consumer involvement relies on a product's complexity, risk, and cost. A product that Foxall highlights as typically exhibiting high consumer involvement is that of a car. In contrast the purchase of baked beans for example, is usually considered a low involvement decision. It was considered important that the context used for the stated preference experiment within this research exhibited a high level of consumer involvement so that consumers were motivated to participate in the full information processing sequence.

- **No limits on the dissemination of findings:** It is considered important that the results from such research would not be restricted for confidentiality reasons due to the context of the research area.

- **Further contribution to knowledge:** It was considered desirable that the stated preference experiment context provides an additional contribution to knowledge.

The following sections describe a research context that meets these research requirements. This context is the development of an environmentally friendly vehicle. The problem of global emissions from passenger transport is first discussed, before examples of government initiatives are presented that aim to promote the development of environmentally cleaner vehicles. The development of the Aerostable Carbon Car (ASCC) under one of these initiatives is then presented, and the need for accurate market research during its development is highlighted. Finally, the use of a stated preference experiment for this market research, as a context to this research is examined in light of the requirements discussed above.

3.4.2 Reducing Global Emissions from Passenger Transport

The environmental damage caused by vehicle emissions is now widely accepted and is increasing on a global scale. Pollution from road transport contributes to climate change and to poor local air quality, affecting public health (CVTF, 2000). The UK Government has set national objectives for reducing the levels of pollutants that are considered harmful to the health of the public and those that affect climate change (DETR, 2000). The need to reduce emissions is clearly recognised. However the benefits of increased personal mobility and door to door transportation offered by the private car has meant that attempts to reduce vehicle numbers and car use have met with only limited success (Swehla and Zali, 1999).

Given the reliance on road transport, Swehla and Zali (1999) suggest that investment is needed immediately so that transportation technology can be fundamentally transformed to stop the increase in emissions of greenhouse and other polluting gases from motor vehicles. Promotion of cleaner vehicles and collaboration between the Government and industry is extremely important.

One UK Government programme that aims to promote the development of more environmentally friendly vehicles is that of the 'Vehicle Foresight Initiative', which is *'the UK's national automotive R&D programme aiming to promote and to stimulate suppliers to develop and demonstrate market driven enabling technologies for future motor vehicles'* (DETR, 2000). John Battle, minister for Science, Energy and Industry, stated at the launch of the programme that *'all systems developed within the Foresight Vehicle programme have the potential to make a significant impact on the use of energy and the emission of pollutants'* (DETR, 2000). Under the Foresight Vehicle programme, the Government pledged £10 million of funding for research partnerships that bring together UK resources and expertise to create components and systems for vehicles of the future. One such research project that is part of this funding is the Aero-stable Carbon Car (ASCC) project, which investigates the limitations of maximising fuel economy in a lightweight car. This project is discussed in more detail in the following section.

3.4.3 The Aerostable Carbon Car

The Composites Manufacturing Research Centre and the International Ecotechnology Research Centre (both at Cranfield University) together with a number of automotive related companies[1] were funded under the Department of Trade and Industry's Vehicle Foresight Programme to undertake a research project that had the ultimate aim of *'designing and taking to prototype stage a commercially viable environmentally friendly car'* (MIL Motoring Research, March 1993).

Current vehicle designs are generally heavy and are fuel inefficient during acceleration (Mills et al., 2001). In order to produce a vehicle with heightened fuel efficiency, this 'Foresight Vehicle' was developed with a much reduced vehicle weight. This process of weight reduction in vehicle design in order to achieve higher

[1] Lotus Engineering, Cranfield Impact Centre, Tenax Fibres, Vantico and Saint-Gobain BTI Europe

fuel efficiency is known in the field as 'decompounding'. However, Mills et al. (2001) state that '*low weight vehicles tend to suffer from poor cross wind stability and require an aerodynamic design that helps them overcome this problem'*. In other words, without high vehicle weight to keep the car on road, it is possible that cross winds could cause difficulties in controlling the vehicle. With these design difficulties understood, the Cranfield led project team therefore developed what would be the Aerostable Carbon Car (ASCC).

The ASCC is a light-weight four-seater aerodynamically stable car made in carbon fibre composites and powered by a small production Honda 660 cc engine. It is expected that the ASCC could achieve fuel efficiency levels of 120mpg – a level clearly far above that of any vehicles currently on the market. The problem of cross wind stability is addressed in this design through innovative aerodynamic styling. Whilst a full sized version of the ASCC has not yet been produced, a CAD impression of the vehicle is depicted in figure 4.

Figure 4 : CAD Impression of the ASCC

The ASCC design has led to new advances in the use of carbon fibre composites. As well as the impressive improvements in achievable fuel-efficiency rates of the vehicle, the development team have also achieved advances in the use of the carbon fibre composite. This has removed *'the high material costs and long processing cycle times* [that] *currently limit the use of composite automotive primary structures to sports and racing cars'* (Mills et al., 2001).

Whilst the achievements in design outlined in this section have clearly contributed to the advancement of scientific knowledge, it remains unclear how they might be perceived by the new car buyer. Could the ASCC compete in the market place and be accepted by new car buyers, or is it simply a project of sole interest to a scientific audience?

3.4.4 Understanding Consumer Valuations of Improvements in Vehicle Designs

Potter et al. (1998) suggests that the cleaner a car is, the more expensive it is to develop and produce. Whilst the development of the ASCC has led to improvements in the manufacturing process, as well as the design of a cleaner vehicle, it is true that

the cost to market of this vehicle is likely to be higher than comparable sized, less efficient cars in its class (Mills et al., 2001). Potter et al. (1998), examining the current fiscal incentives towards cleaner cars, questions a consumer's decision to purchase a fuel-efficient vehicle (in this case a hybrid car) given this extra expense:

> *'when you look at the actual level of tax advantage that you get, it is really quite small and the benefits are fragmented. Would £55 off the VED* [Vehicle Excise Duty] *persuade someone to buy a £20,000 hybrid car rather than a comparable £14,000 conventional car?'*

This is a difficult question to answer. With no such vehicle currently on the general market, it is difficult to measure how a consumer would trade-off the running cost savings of a more fuel-efficient vehicle against the initial purchase price. This suggests that a manufacturer introducing a very new, cleaner vehicle into the market, with what might be extremely innovative design attributes, will still be uncertain as to how their product will be valued by the consumer.

In discussing the development of the ASCC Cousins (1993), suggests that *'consumer acceptance or enthusiasm for the aerodynamic solutions to cross-wind may be a real limit'*. Furthermore Cousins discusses the trade-offs of *'going from four seats to two, moving the engine from the traditional front position to mid vehicle improves safety, weight for weight, but compromises luggage carrying. These may already be seen as limits to decompounding'*. Estimating consumer preferences to these types of design choices is important if the ultimate car design is to be commercially successful.

The Aerostable Carbon Car (ASCC) is predicted to achieve fuel efficiency levels of up to 120 mpg (Cousins, 1993). This is far higher than anything that currently exists in the market. The consumer utilities associated with fuel efficiency levels of this magnitude are unknown. Understanding of these utility levels, and those associated with the design of the vehicle, are very important in estimating the potential market future for such a vehicle. Clearly, when these design attributes are new to the market, these preferences cannot be estimated by examining existing (revealed preference) data on previous purchasing behaviour alone. Stated preference techniques are therefore an extremely useful method to use in this context to understanding how the consumer values the innovative attributes of the ASCC.

The following section considers how a stated preference experiment, measuring how consumers value the attributes of the ASCC, meets the requirements of the research context set in section 3.4.1 of this chapter.

3.4.5 Meeting the Requirements of the Research Context

The original requirements for the research context set in section 3.4.1 were to:

1. Use a consumer choice that exhibits a high level 'consumer involvement'
2. Allow publishable findings (no confidentiality problems)
3. Provide a further contribution to knowledge

Implementing a stated preference experiment that aims to measure how consumers value the different attributes of the Aerostable Carbon Car (ASCC) meets the three requirements set for this research. Discussion in section 3.4.1 of the need for examining a high involvement choice context, highlighted Foxall's (1993) example of the purchase of a car. Clearly market research for a car (the ASCC) meets this requirement exactly, providing a choice context where consumers are motivated to participate in the full information processing sequence.

The second requirement is also met by the discussed research context. Market research for the ASCC forms part of a project funded by the government's Vehicle Foresight Programme. Government initiatives such as this not only allow results to be published, but actively promote dissemination of results.

The third requirement of the research is also met by the described research context. As is highlighted in section 3.4.3 the attributes of the ASCC are highly innovative. Understanding the consumer trade-offs between improvements in fuel-efficiency, and the design characteristics associated with the process of decompounding are unknown. However, the commercial success of a new vehicle such as the ASCC that makes use of these attributes, depends upon these trade-offs. Providing evidence of this trade-off therefore provides a valuable contribution to knowledge in this area.

Given the above discussion, this thesis uses the market research for the Aerostable Carbon Car as the context for the stated preference experiment used within this research. The following section discusses the implementation of the research design, which is carried out using this research context.

3.5 Research Design – Using Think-Aloud Protocol Within a Stated Preference Experiment

This research centres on the implementation of a stated preference experiment, during which think-aloud protocol and stated preference data is collected, and later analysed. The research design can be separated into four distinct stages:

- Stage 1: Pre-stated preference data collection
- Stage 2: Design of the stated preference experiments and implementation using think-aloud protocol
- Stage 3: Analysis of the think-aloud protocol and comparison between sample groups
- Stage 4: Estimation of utility models, and comparison of model parameters using the elicited response data and simulated response data

For clarity, these research stages, and the tasks within these stages are depicted in figure 5. An overview of each of the research design stages follows this figure.

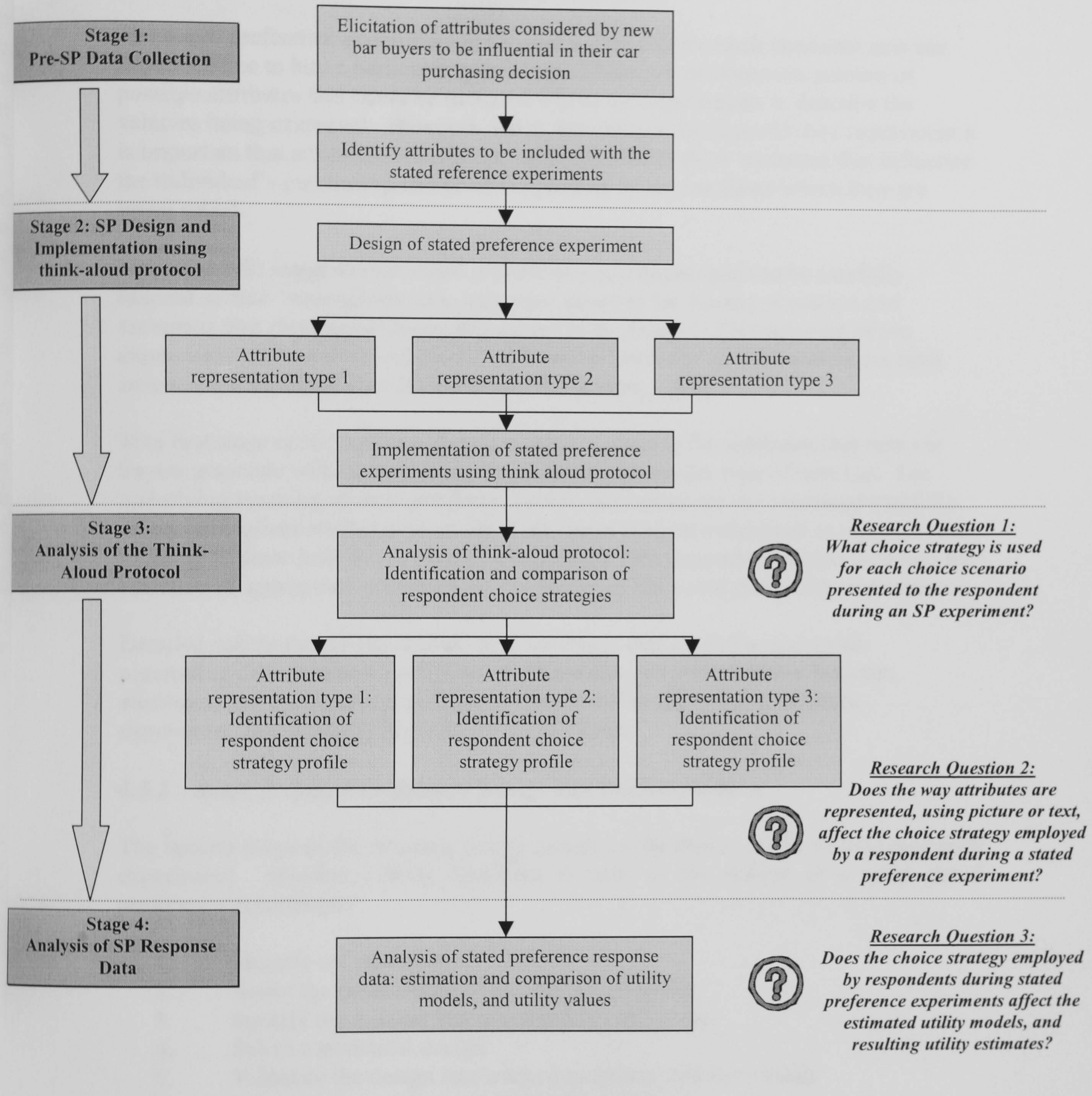


Figure 5: The Research Design

3.5.1 Stage 1: Pre-Stated Preference Data collection

The stated preference experiment to be used within this research examines new car buyers choice to buy a particular type of car. There are an enormous amount of possible attributes that could be included within the experiments to describe the vehicles being examined. However, when designing a stated preference experiment it is important that attributes selected for inclusion reflect those attributes that influence the individual's purchasing choice of the product or service about which they are being asked.

Nelson (1998) suggests that stated preference experiments need to be carefully tailored so that *'respondents face scenarios showing the existing situation and scenarios that they could reasonably expect in the future'*. This tailoring of the experiment uses existing and perceived levels of attributes so that options are built around existing experience (Ortuzar and Willumsen, 1994).

This first stage of the research therefore aims to identify the attributes that new car buyers associate with their decision to purchase a particular type of new car. The underlying meaning of these attributes held by the consumer are examined carefully. The model salient attributes (a group of attributes that are considered to represent the majority of those held by the target audience) are then determined which feed into the selection of appropriate attributes for the design of the stated preference experiment.

Detailed description of the elicitation of attributes that are influential in the purchasing choice of new car buyers, their meaning and interrelation between attributes, and the inclusion of these attributes within the stated preference experiment, are provided in *chapter 4* of this thesis.

3.5.2 Stage 2: Stated Preference Design and Implementation

The second stage of the research design addresses the design of the stated preference experiment. Hensher (1994), identifies 6 tasks in the design of a good stated preference experiment:

1. Identify the attributes
2. Select the measurement units for the attributes
3. Specify the number and magnitude of attributes
4. Select a statistical design
5. Translate the design into a set of questions and show cards
6. Select an appropriate estimation procedure

The first three of these tasks is addressed in the first stage of the research design and relate to the type of car attributes that should be included within the stated preference experiment. This second stage of the research then determines the statistical design of the experiment and the method of translating this design into a set of show cards. This task is of particular importance in this research, as the method of representing attributes is of direct relevance to the research questions.

Three choice-based stated preference experiments were designed. These experiments were the same apart from the method used for presenting the identified attribute 'appearance of vehicle'. This was presented in three different ways, using:

- text
- pictures
- text and pictures

The experiment was presented in the form of a pen and paper exercise. For each choice presented to the respondent, they were asked to state their choice against a five point rating scale.

As discussed earlier in this thesis (section 1.3.3), Nelson (1998) also examines the impact of different methods of representing attributes in stated preference experiments on responses made by individuals within the experiments. Nelson's research presented each respondent with a series of stated preference experiments all aiming to measure the same attribute trade-offs, but with the attributes represented differently. This meant that the sample group responding to each experiment was identical, and should therefore have resulted in the same consumer valuations associated with each of the attributes included within the presented choices. By using identical samples for each of the experiments, Nelson removed the possibility that there were different sets of preferences held by each of the sample groups. However, this sampling method is problematic. In this research, the text-only experiment would have to be presented to every respondent first to be able to ensure that responses were not based upon a stored memory of the vehicle pictures presented in the experiments that contain pictures. This could produce potential bias in the results as respondent fatigue could impact on the choice strategy and response made by respondents answering multiple experiments that are presented in the same order. The three different stated preference experiments were therefore presented to three independent samples within this research. This removed the potential bias identified above with the order in which the experiments were presented to respondents. To ensure that similar sample groups were maintained information relating to the age and sex of the respondents within each of the groups was also collected, so that sample groups could be compared.

During the implementation of the three stated preference experiments, respondents were requested to 'think aloud' their thought processes. The transcripts from these think-aloud protocols were analysed in third stage of the research, discussed in the next section.

A detailed description of this second stage of the research design is presented in *chapter 5* of this thesis.

3.5.3 Stage 3: Analysis of the Think-Aloud Protocol

Stage 3 of the research design analyses the think-aloud protocol collected during the stated preference experiments. A clear analytical framework is presented that aims to identify for each choice made by a respondent during the three stated preference experiments the choice strategy employed (research question 1).

Examination of these identified choice strategies is made to:

- Identify any choice strategy bias associated with specific choice cards
- Test whether respondents consistently use the same choice strategy during throughout the stated preference experiment
- Identify any relationship between the choice strategy used by respondents and the method used for representing attributes within the stated preference experiments (research question 2)

Stage 3 of this research design is discussed in detail in *chapter 6* of this PhD thesis.

3.5.4 Stage 4: Estimation and Comparison of Utility Models and Utility Values

The third research question aims to identify the impact of differing choice strategies used by respondents in stated preference experiments on the estimation of consumer utility models. This is achieved through the estimation of consumer utility models from the response data collected during the implementation of the stated preference experiments (stage 2). The choice strategies used by respondents during the three different stated preference experiments is compared with the estimated utility models associated with each of the three experiments

Section 3.5.3 explained that this research used three independent samples for each of the stated preference experiments implemented, to eliminate possible response bias. Whilst care was taken to collect data relating to the age and sex of the sample groups to ensure that the groups were similar, this sampling method is still considered to exhibit potential problems. The use of independent samples for each of the experiments could mean that differences in the estimated models might be caused for reasons other than differences in the identified choice strategies. Differences identified in the estimated models might be because:

- **Different sets of preferences are held between the three different sample groups.**
  Whilst it is expected that there is variation in preferences across a sample group, if the variation differs between each of the sample groups then this will impact on the responses elicited for each of the sample groups and therefore the estimated model parameters.

- **Differences in the way the alternatively represented attributes were comprehended by the three different sample groups.**
  As one of the vehicles (the ASCC) represented in the choice scenarios presented to respondents was a vehicle that is not currently available or known in the marketplace, respondents who were shown the text only choice card may have held a different mental image of the vehicle described to those respondents who were presented a picture of the vehicle.

It is not possible therefore to single out the direct impact of the profile of choice strategies employed by each of the sample groups, on their responses and the

estimated parameters of the resulting utility models estimated. Differences in the utility models estimated from differing identified choice strategies are also examined therefore using simulation techniques.

Examination of the utility models produced from the response data collected during the stated preference experiments implemented in stage 2 is presented in chapter 7 to provide an indication of the possible impact any differences in the choice strategies employed by respondents on the associated utility models that are estimated. However, given the limitations of attributing any identified differences in the models estimated to differences in the choice strategies used by respondents from the different samples, chapter 8 presents further examination of the impact of different choice strategies used by respondents on the resulting estimated utility models, which make use of simulated response data.

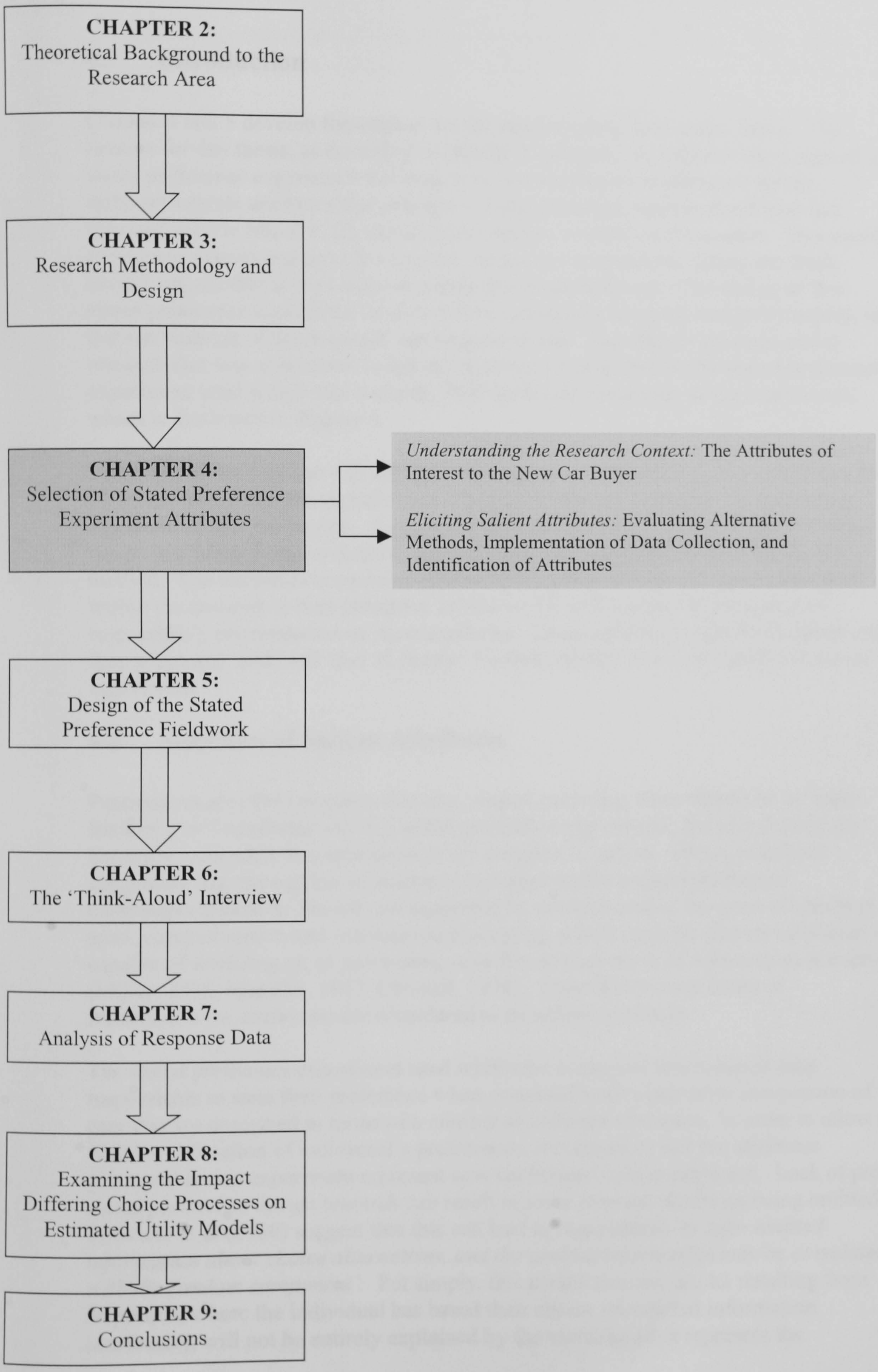
3.6 Conclusions

This chapter has re-examined the research questions addressed within this research, and presents the philosophical underpinnings associated with these questions, before explaining the adopted research strategy employed in this research. Alternative data collection methods were then discussed and evaluated in terms of their ability to address the research question, before identifying the most appropriate methods for this research – the use of think aloud protocol within the context of a full stated preference experiment.

The implemented research design was then discussed in more detail, explaining the chosen context for the research, and the four stages in the data collection and analysis that was undertaken. In summary, these four stages are:

- Stage 1: Pre-stated preference data collection - identifying the attributes for inclusion within the stated preference experiment;
- Stage 2: The design and implementation of a stated preference experiment, using think-aloud protocol;
- Stage 3: Analysis of the think-aloud data;
- Stage 4: Analysis of collected, and simulated stated preference response data.

CHAPTER 4: SELECTION OF ATTRIBUTES FOR THE STATED PREFERENCE EXPERIMENT


CHAPTER 2:
Theoretical Background to the Research Area
CHAPTER 3:
Research Methodology and Design
CHAPTER 4:
Selection of Stated Preference Experiment Attributes
Understanding the Research Context: The Attributes of Interest to the New Car Buyer
Eliciting Salient Attributes: Evaluating Alternative Methods, Implementation of Data Collection, and Identification of Attributes
CHAPTER 5:
Design of the Stated Preference Fieldwork
CHAPTER 6:
The 'Think-Aloud' Interview
CHAPTER 7:
Analysis of Response Data
CHAPTER 8:
Examining the Impact Differing Choice Processes on Estimated Utility Models
CHAPTER 9:
Conclusions

4.1 Introduction

Chapter 4 and 5 develop the context for the research described in this thesis. The context for this thesis, as described in chapter 3 (section 3.4), requires the design of a stated preference experiment that measures new car buyers preferences for the different vehicle attributes that describe a choice between a newly developed fuel efficient vehicle (the ASCC) and another vehicle currently on the market. This stated preference experiment provides the task context for respondents during the think-aloud protocol that is implemented within the research design. The design of this stated preference experiment aims to follow commonly accepted design principles, so that the findings of this research can be generalised. This chapter presents initial research that was undertaken to aid the selection of attributes for the stated preference experiment used within this research. That feeds into the design of the experiment, which is described in chapter 5.

The next section (section 4.2) explains the importance of selecting those attributes for inclusion within the stated preference experiment that are salient to the purchasing decisions of new car buyers. Section 4.3 presents alternative methods for eliciting salient attributes from car buyers, and described the implementation of the chosen method. The attributes considered salient by the group of new car buyers included within the research is then presented in section 4.6 with a detailed discussion of respondent's interpretation of these attributes. Those attributes considered salient are then presented, and used later in chapter 5 within the design of the stated preference experiment.

4.2 Selection of Salient Attributes

Pearmain et al (1991) suggests that as a general guideline, there should be an upper limit of 6 or 7 attributes within a stated preference experiment, and less if some are currently unfamiliar to respondents or are complex to define. These guidelines suggesting that the number of attributes included within a stated preference experiment should be limited, are supported by research within the areas of attention span, comprehension and information processing, which suggests that an individual is capable of attending to, or processing, only five to nine items of information at a time (Miller, 1956; Mandler, 1967, Chisnall, 1994). These five to nine items of information (or attributes) are considered to be *salient attributes*.

The stated preference experiment used within the context of this research asks respondents to state their preference when presented with a pair-wise comparison of cars that are described in terms of a number of different attributes. In order to allow a realistic estimation of individual's preferences, it is essential that the attributes portrayed in this experiment represent new car buyers' salient attributes. Lack of pre-stated preference design research can result in some relevant attributes being omitted. Louviere et al (2000) suggest that this can lead to respondents *'to infer omitted information about choice alternatives, and the omitted information may be correlated with the random component'*. Put simply, this means that any model resulting from responses, where the individual has based their choice on omitted information (attributes), will not be entirely explained by the variables (that represent the

attributes) included within the model. The implications of this effect for the use of resulting models for forecasting purchasing behaviour can be difficult. Louviere et al. (2000) state:

> *'Models estimated from such tasks will be of limited value for future forecasting if the covariance of the structure of the omitted variables changes. Such changes should be slower in established, mature markets, but may be rapid in new and emerging markets'.*

In light of this problem, which is particularly relevant to the fast-changing new car market, Louviere et al (2000) emphasise the importance of understanding the choice problem being addressed in a stated preference experiment during the design phase of the research:

> *'Such effects can be minimised by spending as much time as possible in advance if the design of the experiment and field work to understand the problem faced by consumers as thoroughly as possible'*

This first stage of this research therefore aims to elicit the salient attributes considered by new car buyers in their purchasing decision - that is, to elicit those five to nine vehicle attributes that car buyers base their intention towards buying a particular new car on.

4.3 Eliciting Salient Attributes

4.3.1 Alternative Methods for Eliciting Salient Product Attributes Relating to the Purchasing Decision

Methods for understanding the purchasing choice facing the consumer, and the elicitation of salient attributes, are rarely discussed within stated preference literature. However from a thorough literature review four main data collection methods were identified for the identification of attributes within the stated preference literature:

- Use of secondary data, or knowledge of researcher (Louviere, 2000; Green and Srinivasan, 1979)
- Individual Depth Interviews (Braun and Srinivasan, 1975; Nelson, 1992; Louviere et al, 2000)
- Focus Group Interviews (Green and Srinivasan, 1979; Nelson, 1998)
- Kelly's Repertory Grid (Green and Srinivasan, 1979)

Description of these alternative methods, and their application for the elicitation of salient attributes are provided in the following sections. A further method, which has not been identified within the stated preference literature, is also considered for application within this research – the method of 'cognitive mapping'.

4.3.2 Secondary Data or Knowledge of the Researcher

Types of secondary data are those that have already been collected for some other purpose. This can be either raw data or published summaries, and includes both quantitative and qualitative data. Saunders et al. (2000) suggest that the main reason for using secondary data for many research objectives is the savings in resources – in particular time and money. They state:

> *'In general it is much less expensive to use secondary data than to collect the data yourself... ...You will also have more time to think about theoretical aims and substantive issues as your data will already be collected and subsequently to be able to spend more time and effort analysing and interpreting the data'.*

However, Saunders et al. also emphasise the limitations of using secondary data including:

- The data may be collected for a purpose that does not match your need, and may be inappropriate to your research objectives.
- Access to the data may be difficult or costly – in particular where data has been collected for commercial reasons.

In the context of pre-stated preference data collection used to identify attributes for inclusion within a stated preference experiment, the use of secondary data is problematic. The preferences being measured in stated preference exercises relate to very specific choice situations. Finding available secondary data specific to these situations is extremely difficult. Within the context of the choice of purchasing a specific type of new car, a further problem arises in the availability of such secondary data. Whilst vehicle manufacturers undertake detailed consumer studies in the development of their products, this information is subject to commercial confidentiality, and not available within the public domain.

In an area where the researcher has a high level of expertise and previous research experience, it might be considered appropriate for the researcher to select stated preference attributes from his/her own knowledge of the choice context in question. However this approach introduces the possibility of researcher bias in the design of the stated preference experiment. When considering the research undertaken to determine the attributes of a stated preference experiment and gain insights into how consumers make choices, Louviere et al (2000) comments on both using the researcher's own knowledge, or secondary data:

> *'Such insights rarely can be gained by sitting in one's office speculating about the behaviour of real consumers. Nor can they be gained by waiting for data from scanner panels or other sources to be supplied, and formulating models based on data collected by others for purposes other than that explicitly intended by the researcher... ... Statistical and econometric ability is no substitute for theory, thinking, observation and just plain hard, empirical detective work'.*

In light of the problems relating to the use of the knowledge of the researcher or secondary data for the design of stated preference attributes, the following sections consider methods of eliciting *primary* data from consumers about their attributes relating to the purchase of a new car.

4.3.3 Focus Groups

One type of primary data research frequently employed by stated preference practitioners is the use of focus groups. Focus groups are also known as 'focused groups' or 'group depth interviews' or 'discussion groups' and are *'the most commonly used qualitative technique in applied settings'* (Mariamapolski, 2001).

Tynan (1986) describes focus group interviews as a:

> *"qualitative method in which a small sample of respondents discuss elected topics as a group for approximately one to two hours. A moderator focuses the discussion on to relevant subjects in a non-directive manner."*

Researchers can use focus groups, drawn from the target sample group, to understand more fully the sample's attributes about a particular object, or action. Nelson (1998) provides a good example of the use of focus groups to identify attributes for inclusion in a stated preference experiment that aimed to measure the monetary valuation of the environmental impact of road transport. Focus groups were asked to talk about the researched object/action in a free response format.

Nelson (1998) suggests that 'G*roup discussions have advantages in that although they use a small sample of respondents, they generate a rich source of data and are very flexible'.* Further advantages with the use of focus groups, are also presented by Mariampolski (2001):

- Focus groups allow for group interactions among participant; thus the researcher can learn about patterns of interpersonal influence regarding a specific product or communication.
- Peer pressure in a focus group can support honest disclosure. Participants may be less likely to falsify their attitudes if they perceive themselves to be among similar types of people.

- Focus groups are flexible. They can be conducted with just about any type of targeted audience or at any time of year.

However there are also several large disadvantages associated with the use of focus groups. Miriampolski (2001) states that:

> *'most internal problems with focus groups are a consequence of problematic group dynamics... group opinions may seem to be swayed by dominating respondents. Passive or shy respondents may feel reluctant to challenge a forceful group member'.*

However the operation of group dynamics in this kind of research can open the responses up to bias. Craig and Douglas (1999) also suggest that the *'primary limitation* [to focus groups] *is that respondents may tend to express socially acceptable views and to avoid opinions that may be controversial'*. This is supported by Miriampolski (2001), who states that *'some participants may feel reluctant to express an unpopular opinion and the moderator in this situation may lack the skills to facilitate diverse opinions'*.

The communication with the target sample that is gained through the use of focus groups, in comparison to the reliance of the researcher on secondary data, or their own knowledge, will in all probability aid the researcher in improving the understanding of the attributes that influence new car buyers purchasing decisions. However, given the potential for group dynamics in limiting the elicitation of the salient attributes considered by *individuals* in their car buying decision, this research method was not considered the most appropriate tool for identifying salient attributes. The next section considers the use of individual interviews to elicit the attributes considered salient by new car buyers in their vehicle purchasing decision.

4.3.4 Individual Interviews

An individual interview is a term that relates to a number of different types of interview. A number of categorisations have been presented within methodological literature. Saunders et al (2000) present a commonly used typology that relates to the level of formality and structure in the interview, where interviews are categorised as: a structured interview, a semi-structured interview, or an in-depth interview.

- *Structured interviews* are based on a predetermined, standardised set of questions. Saunders et al (2000) emphasise that the researcher should ensure that questions are read using the same tone of voice for each question to prevent indicating any bias. Responses are then recorded in a standardised format.

- *Semi-structured interviews* make use of a list of themes and questions held by the researcher, although their usage may vary from interview to interview (Saunders et al, 2000).

- *In-depth interviews* allow the respondent to talk freely about the general subject area being researched. Within the field of market research within which this research sits, Miriamploski (2001) suggests that this type of interview is preferred when:

'the project demands intensive probing of respondents, or reactions to ideas without influence from peers. IDIs [Individual Depth Interviews] *facilitate a high degree of psychological depth, that is, investigation of motivations, associations and explanation behind product preference'.*

Saunders et al. (2000) suggest that in this type of interview *'there is no predetermined list of questions to work through in this situation, although you need to have a clear idea about the aspects you want to explore'.*

A similar distinction between the level of structure in interview types has been made between *standardised interviews* and *non-standardised interviews* (Healey and Rawlinson, 1993). Robson (1993) also makes a distinction between respondent interviews (where the interviewee responds to the questions of the interviewer) and informant interviews (where the interviewee is controls the interview and talks freely about the topic area).

Interviews can provide a useful method of eliciting the attributes that consumers believe influence their decision to purchase a particular type of new car. The types of interview most appropriate for exploring vehicle attributes that are salient to a consumer's purchase are likely to be the semi-structured or in-depth interview. Robson. (1993) suggests that *'in an exploratory study, in-depth interviews can be very helpful to 'find out what is happening* [and] *to seek new insights'.* Saunders et al. (2000) also suggests that semi-structured interviews may also be used in relation to an exploratory study.

Within the stated preference literature it is such semi-structured interviews that have been used to identify relevant consumer attributes to aid the design of the stated preference experiment. For example, Nelson (1992) describes the use of an interview where respondents are asked a standardised question relating their decision to travel by a particular mode. In Nelson's interviews respondents were then allowed to respond in a free response format describing their attributes. Whilst no example cases are described, Louviere et al (2000) also suggest that unstructured interviews with consumers are appropriate for aiding the design of a stated preference experiment.

Two further techniques for eliciting attributes were also considered for eliciting the salient attributes associated with new car buying decisions – repertory grid technique, and cognitive mapping. These techniques are carried out within the context of an individual interview. The next section considers the use of repertory grid technique.

4.3.5 Repertory Grid Technique

Repertory Grid technique was developed by George Kelly as an application of his Personal Construct Theory (Kelly, 1955; Bradshaw et al, 1987; Gaines and Shaw, 1993). Fransella and Bannister (1977), in their '*Manual for Repertory Grid Technique*' suggest that repertory grid is a useful interviewing technique for exploring the structure and content of a:

> *'person's theories - his personal construct system – that might be referred to in other psychological approaches as his personality, his attitudes, his habits, his reinforcement history, his information coding system, his psychodynamics, his concepts his philosophy or his central nervous system'*

Whilst Kelly first developed repertory grid for use of understanding personal construct systems in the field of psychotherapy, it has also been used from early on in other areas, including market research (for example, see Worcester, 1972), defining management competences and evaluating training needs (Easterby-Smith, 1991).

Reger (1990) states that

> *'in operationalising personal construct theory, rep grid allows the researcher to elicit the similarities and differences that constitute the constructs (or dimensions) a respondent uses to differentiate among elements'.*

The constructs (sometimes referred to as dimensions) that are elicited within the repertory grid interview could also be described as attributes as in stated preference experiments. There are three key states to the implementation of a repertory grid interview: selecting elements, eliciting constructs, and eliciting perceptions of elements in terms of constructs (Reger 1990):

1. ***Selecting elements***: Elements could be people or objects, or they may be properties of people or objects such as strategies (Reger, 1990). Within the field of market research, Worcester (1972) describes the use of elements as stimuli such as products, brands and concept statements. Reger (1990) suggests that researchers may decide to provide the elements if they are interested in learning more about a given set of elements but also states that *'respondents may be allowed to provide a their own elements when researchers are unsure which elements are relevant.'*

2. ***Eliciting constructs***: Constructs are either elicited through asking about elements in triads (Kelly, 1955, Fransella and Bannister, 1977, Reger, 1990) or less frequently in pairs. In the triad condition three elements are presented and the individual is asked how one of them is different to the other two and in what way these two are similar.

3. ***Eliciting perceptions of elements in terms of the constructs:*** Respondents are asked to rank or rate the constructs that have been elicited according to how similar they are to the extreme position (or pole). Reger (1990) suggests that:

   'Rating grids allow the most flexibility of responses. The respondent rates each element on a scale to indicate his perception of the element's degree of similarity to the likeness pole versus the similarity to the contrast pole'.

Figure 6 shows a basic repertory grid elicited from a geographer about spatial mapping techniques presented in a study by Gaines and Shaw (1995). The mapping techniques used as elements are listed as column names at the bottom. The poles of the constructs (attributes) elicited are listed on the left and the right as row names. The ratings of the mapping techniques along the dimensions of the constructs form the body of the grid. For example, "probability mapping" is rated 8 (on a scale of 1 to 9) on the dimension "qualitative and quantitative--quantitative" which means that it is construed as primarily "quantitative."

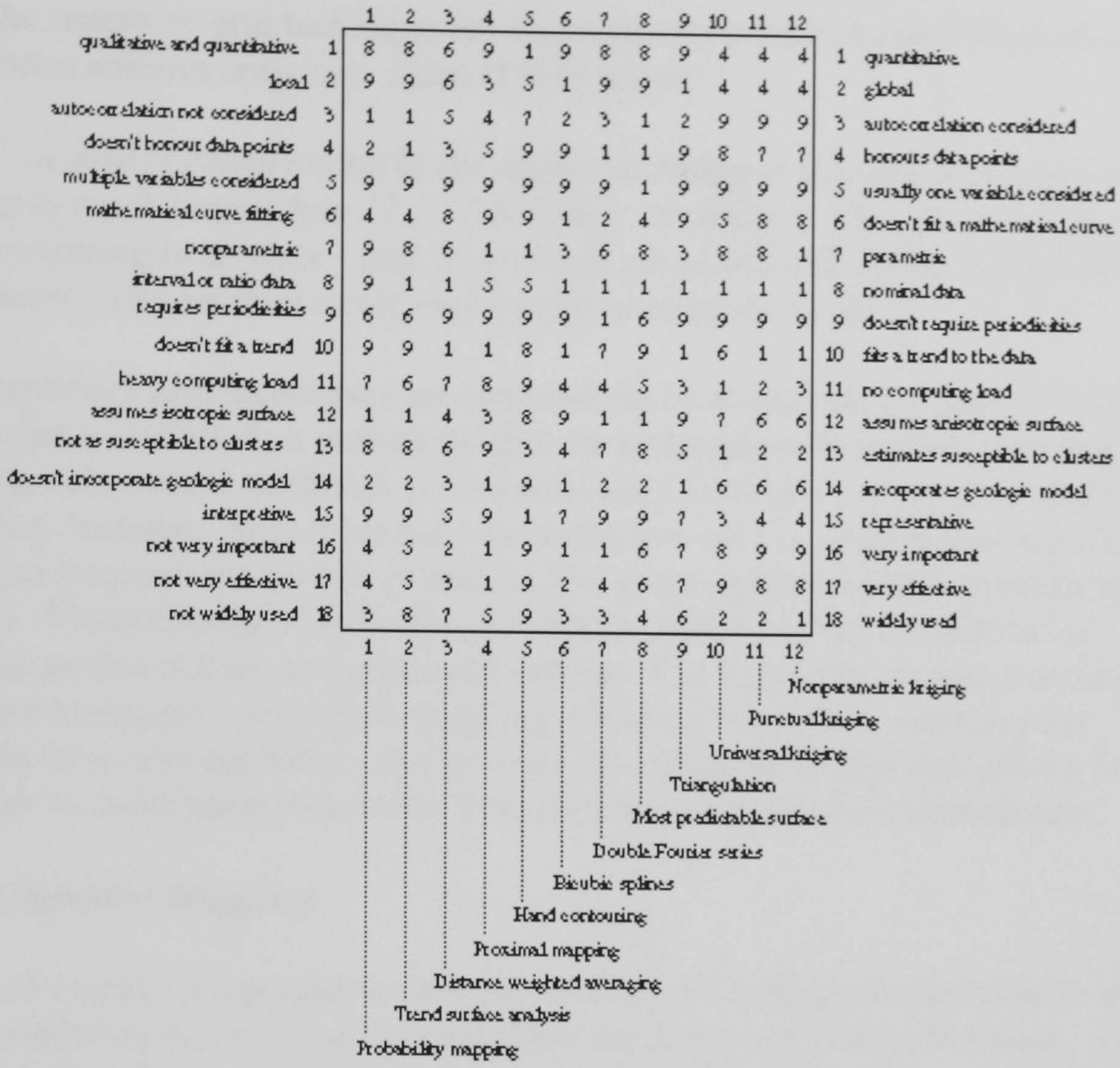


Figure 6: An Example of a Repertory Grid

Statistical analysis of an individual's rating grid can take the form of factor analysis, cluster analysis, and multidimensional scaling (Reger, 1990). Reger does suggest however that *'Quantitative analysis between subjects which seeks to compare the content of rating grids is less theoretically appropriate, especially under strict adherence to Kelly's (1955) personal construct theory'.*

Application of repertory grid for the use in the determination of attributes for inclusion within a stated preference experiment can be achieved using the first two stages of the repertory grid interview outlined above (Green and Srinivasan, 1979). The elements selected for presentation to the respondent could be stimuli relating to product varieties (in this case different models of new car). Alternatively, respondents could be asked to name different stimuli themselves (different models of cars that are known to them). The second stage of the interview process, the elicitation of constructs (or attributes), would allow these stimuli to be presented to the respondent two, or three at a time, and similarities and/or differences between cues elicited from the respondent. These elicited constructs could inform the design of the stated preference experiment, by aiding the selection of attributes for inclusion.

Reger (1990) highlights the benefits of the use of repertory grid techniques:

> *'rep grid allows the researchers to tap into the respondents' cognitive constructions of the phenomenon of interest instead of forcing them to fit their perceptions into the cognitive structure of the researcher'*

Whilst the repertory grid technique has its apparent benefits, as described above, it has not been without criticism. Eden (1988) states:

> *'...a grid is constraining in the degree of richness that can be captured - a grid much larger than 12 x 12 becomes unwieldy to elicit and even more confusing to analyse - and yet a single client will talk about a problem with more richness than could ever be captured by such a grid.'*

Whilst repertory grid techniques are reported above to provide a degree of richness in the data that is collected, it is unlikely that the technique will provide data that represents only *salient* attributes (constructs) used by a new car buyer in about their purchasing decision. This is because the technique asks respondents to identify *differences* between the stimuli (elements that in the context of this research might be vehicles). Identification of *differences* between vehicles is not considered to guarantee attributes that are considered *salient*. The following section considers an alternative technique – cognitive mapping, which in addition to enabling the elicitation of salient attributes, also provides the richness of data that allows the researcher to understand respondent's interpretation of the elicited attributes.

4.3.6 Cognitive Mapping

The use of cognitive mapping within the context of a individual interview to elicit product attributes has not been found within the stated preference literature. However the technique is in line with Louviere et al's (2000) recommendation to gain a detailed understanding of the choice problem faced by the respondents. This section discusses the possible use of cognitive mapping within the context of an in-depth interview, to aid the understanding of attributes salient to the new car buyer, and so aid the identification of attributes stated preference experiment.

Pidd (1996) describes cognitive maps as *'intended for use by someone who wishes to understand elements of the thought of another person or group'*. Within the field market research, Mariampolski (2001) suggests that the objective of a mapping exercise is *'to develop a written depiction of inherent mental images associated with brands or product categories'*. She suggests that *'mind maps are useful for both developing and elaborating concepts'*.

> *'careful verbatim transcripts of... recorded tapes... preserv[e] the raw data in as 'hard' a form as could be wished. At the same time, information processing models of the cognitive processes provide a basis for making the encoding process explicit and objective.'* (Ericsson and Simon, 1984)

Huff (1990) provides to date the most detailed and thorough discussion of the techniques. She presents a breakdown of the types of cognitive mapping used by researchers. This classification is later presented clearly in a figure by Jenkins (1995) and is presented here as figure 7.

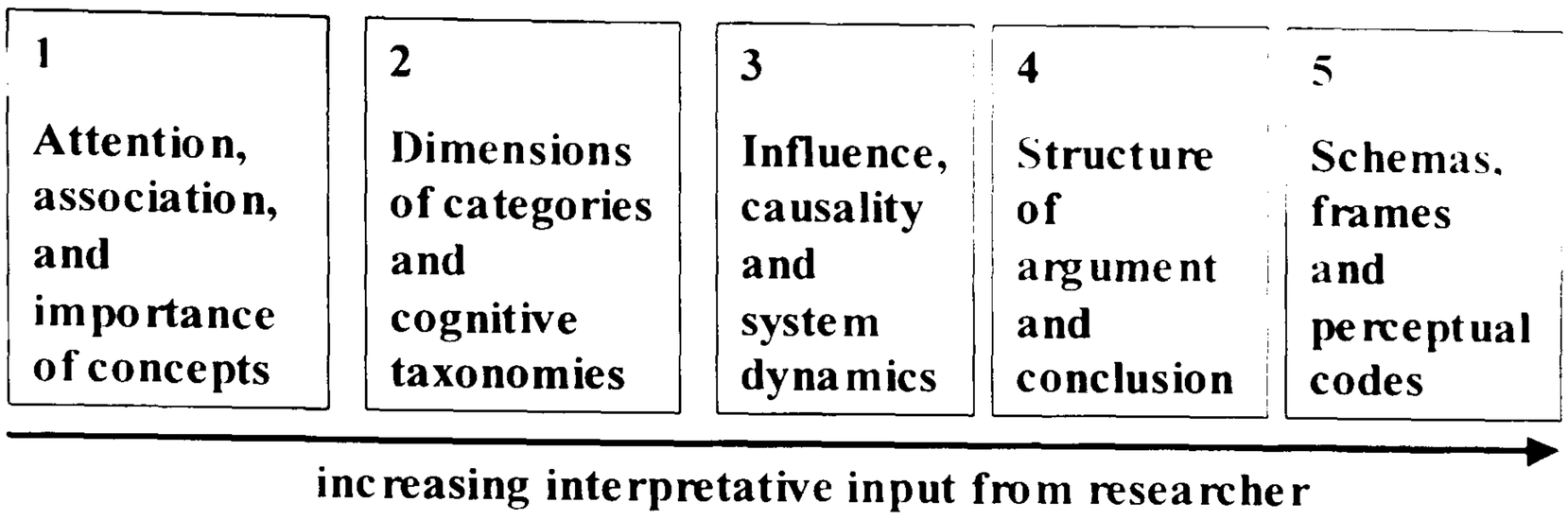


Figure 7: Five Types of Cognitive Maps (Jenkins, 1995; adapted from Huff, 1990)

Huff suggests that cognitive maps can be placed on a continuum:

> *'At one end of the continuum are mapping methods that deal with 'manifest content' (Berelson, 1952). The underlying, often implicit, model of cognition is relatively simple, and verbal expression is taken as a direct indication of mental activity... ... At the other end of the continuum are methods that have been developed in the field of anthropology, linguistics, literary criticism and artificial intelligence. These methods involve considerable interpretation by the researcher, and they draw on more complicated models of cognition'.*

The second of the five types of cognitive mapping described by Huff (1990), that elicits dimensions of categories and cognitive taxonomies from respondents, that is considered most appropriate for this research. Huff states:

> *'Empirical research and theory in cognitive psychology supports the map maker in drawing maps that dichotomise concepts and show hierarchical relationships among broad concepts and more specific subcategories'.*

Mariampolski (2001) suggests that this type of mapping can be implemented by:

> *'Placing the main idea at the centre of the page. Then, the first subsequent word s that come to mind in connection with the main idea are placed around it. Next the further associations are connected and a set of idea 'trees' are elaborated until the respondent can go no further'.*

Unlike repertory grid technique, this type of cognitive mapping allows direct elicitation of those attributes that respondents consider in their new car buying purchasing decisions, and is therefore considered a useful technique to use in conjunction with individual interviews. This type of cognitive mapping also allows the researcher to gain a clearer understanding of the respondents underlying meaning behind each attribute statement elicited, than other types of structured or semi structured interview. This understanding allows the researcher to code respondent's elicited attributes with greater ease, during the aggregation of data. The type of cognitive mapping described by Huff (1990) also limits the level of interpretation by

the researcher, which is consistent with the philosophical assumptions made in this research design (as described in chapter 3, section 3.2.2).

4.3.7 Development of an Appropriate Data Collection Technique

Five alternative methods have been considered for the selection of attributes for inclusion within the stated preference experiment:

- Use of secondary data, or knowledge of researcher
- Individual depth interviews
- Focus group interviews
- Kelly's repertory grid
- Cognitive mapping

The use of secondary data or the knowledge of the researcher was rejected as an appropriate method, because it leaves the design of the stated preference research open to researcher bias. Furthermore, it is questionable whether appropriate secondary data is available that meets the requirements of the choice context being considered in this research. The use of focus groups was also rejected, as a result of the problems associated with group dynamics, and the possibilities of peer influence on the views expressed.

The use of individual interviews was considered an appropriate method of eliciting the vehicle attributes that are salient to a new car buyers purchasing decision. This type of interview allowed direct elicitation of the attributes from the targeted new car buyers, but unlike focus groups does not suffer from the problems associated with group dynamics and peer influence. However, it is considered important that within this interview, respondents provide a clear understanding of the meaning of the underlying attribute statements. Towriss (1981) suggests that '*a potential source of systematic bias in all research involving the use of free response information is that stemming from the coding of responses*'. Respondents often use different phraseology to describe the same attribute, for example '*good fuel efficiency*' and '*good miles per gallon*'. The decision whether to class two different statements as meaning the same is clearly a matter of judgement on behalf of the researcher, and so gives rise to the possibility of researcher bias. The use of either repertory grid or cognitive mapping was considered to aid the attribute elicitation process and provide further depth of understanding of the meaning of respondent's elicited statements. Unlike repertory grid, which elicits attributes that are different between vehicles, cognitive mapping can be used to directly identify those attributes that are salient in the new car buyer's purchasing decision.

The application of cognitive mapping within the context of an individual interview, for the elicitation of attributes for inclusion within the stated preference experiment used in this research, is explained in the following section.

4.4 Interview Structure and Protocol

The individual interview implemented within this research to elicit the salient attributes associated with the purchasing decision of a new car is described in this section. The interview was split into four distinct stages, which includes the protocol suggested by Miriampolski (2001):

- Collection of information relating to the sex and age category of the respondents
- Elicitation of salient attributes in the new car buyers' purchasing decision
- Mapping of the respondent's interpretation of the elicited attributes; collection of a cognitive map
- Summarising and confirming the elicited attributes, and their underlying meaning with the respondent

These four stages are described below and then summarised in figure 8.

In the first stage of the interview, information relating to the respondents age and sex was collected. This was undertaken to understand the basic demographics associated with the sample used in the research. This would allow later comparison to be made with the demographics of the sample groups used in the main stated preference data collection phase. Ensuring that the attributes for inclusion in the design of the experiment are elicited from a similar sample to those used in the stated preference fieldwork increases the likelihood that those attributes presented to the later samples are salient to their choice process.

In the second stage of the interview, attributes salient in the new car buyer's purchasing decision were elicited in a free response format. Individuals from the target sample (to be discussed in section 4.5) were asked: *'What factors do you consider in your decision to purchase a particular type of new car?'*. In section 4.2 the area of attribute saliency was discussed, which suggested that an individual holds no more than 9 salient attributes about a given purchasing behaviour. Therefore, up to nine attributes were recorded from each respondent in response to the above statement.

Once a list of attributes had been elicited, respondents are asked in the third stage of the interview to explore these attributes in more detail using a cognitive mapping approach, as described in section 4.3.6. This is to aid the coding of responses later in the research process (discussed later in the chapter). These explanations were elicited after all the attributes were first elicited from the respondent. This ensured that the elicitation of salient attributes wasn't influenced by the researcher. In line with the description of cognitive mapping provided by Miriampolski (2001), one of the respondent's elicited attributes was placed in the centre of a piece of paper. The respondent was then asked to explain the meaning of the attribute. The first subsequent words that were then elicited in association with the main attribute were placed around it. Next the further associations are connected and a set of idea 'trees' are elaborated until the respondent could go no further. This process was carried out for each attribute elicited from the respondent.

The final stage of the interview, reviewed with the respondent the researcher's interpretation of the elicited attributes, using the cognitive maps that had been treated. This final stage was carried out to limit potential researcher bias and to confirm that the researcher's description adequately described the attribute that the subject was seeking to elucidate.

Appendix D presents an example of the fieldwork documents collected in this stage of the research.

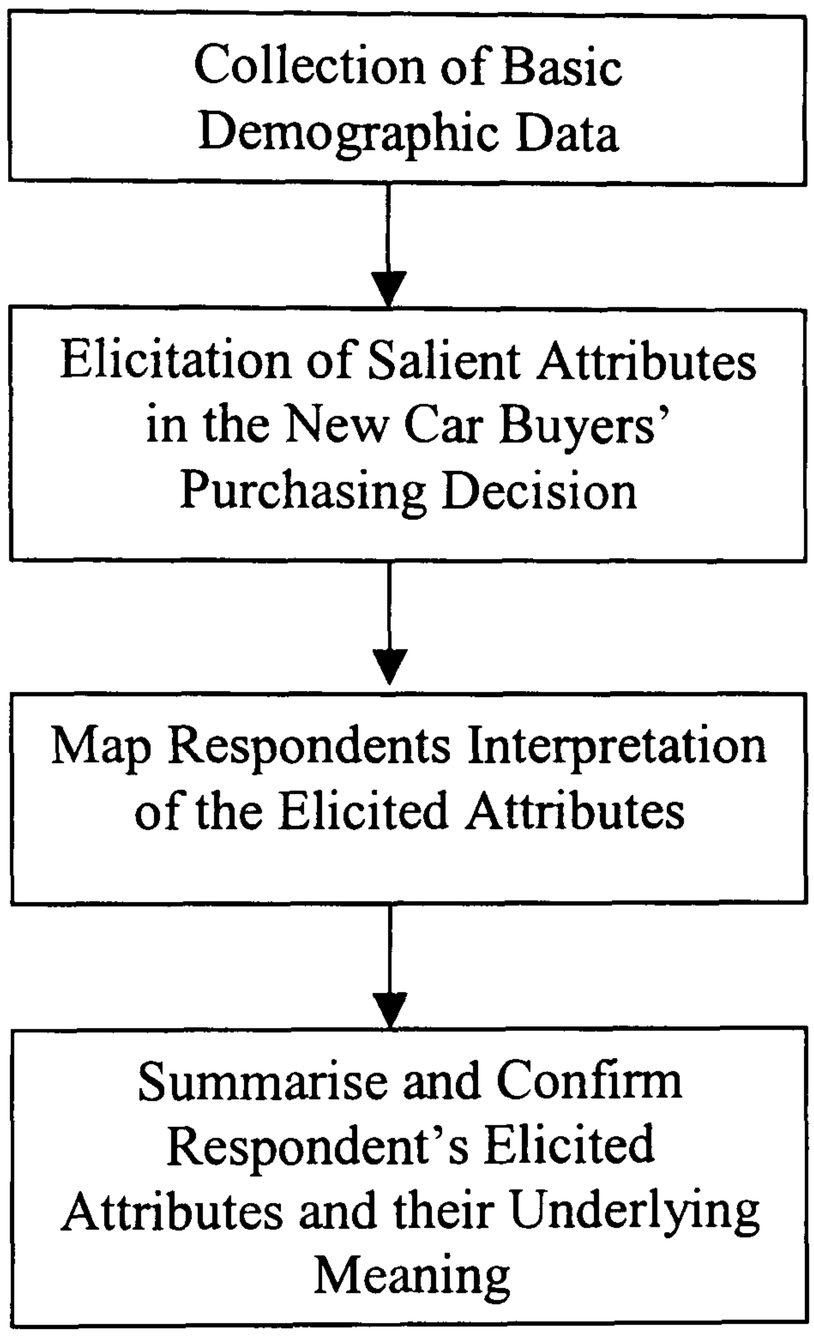


Figure: 8: Eliciting Attributes – the Interview Protocol

4.5 Sample Frame

4.5.1 Identifying the Target Sample for the Research

The attributes elicited within the interviews described in this chapter aid the selection of attributes for the stated preference experiment that provides the context for this research. It is important that the respondents targeted within these interviews represent the same type of sample group as those that are to be targeted within the stated preference experiment described later in this thesis. This is important because different types of sample groups may hold differing salient vehicle attributes, upon which a car purchasing decision is made. This section therefore describes the sampling strategy for both this pre-stated preference design research, and for the implementation of the stated preference experiment itself (described in chapter 5).

As the stated preference experiment, and this pre-stated preference design research, focuses on the decision made by *new* car buyers, it is important that it is this group that are used within the research. However, Towriss (1981) suggests that there are several alternative strategies open to the researcher for the sampling of new car buyers: interviewing buyers after purchasing their vehicle; interviewing buyers before their purchasing decision; or interviewing buyers during their purchasing decision.

- *Interviewing buyers after their purchasing decision:*
  This takes a retrospective approach involving the sampling of new car buyers at some point in time after the car has been purchased. Whilst this sample has the advantage of being relatively easy to identify (through dealers' records), the approach suffers from two drawbacks: the potential for different salient attributes to have been developed since the purchase of the vehicle and the potential for post-rationalisation of their purchase (cognitive dissonance).

  Festinger (1978) suggests that *'the magnitude of post-decision dissonance is an increasing function of the general importance of the decision and of the relative attractiveness of the unchosen alternatives'*. The purchase of a new car is a high involvement decision, and so there exists a large potential for a high level of post-decision dissonance. Chisnall (1994) suggests that buyers: *'will endeavour to reassure themselves by seeking information in support of their chosen product, and also by avoiding sources of information which are likely to reduce their buying confidence'*. Buyers after their purchasing decision are therefore considered an unsuitable sample for this research – as they are unlikely to make an informed and balanced choice.

- *Interviewing buyers before their purchasing decision:*
  Such a sample could be identified using existing owners of new cars and identifying the attributes they consider when buying a new vehicle, under the assumption that they would be likely to purchase a car in the future. This approach suffers from the problem that different attributes may be learned prior to the purchase of the next car. It also limits the sample to those individuals who have purchased a new vehicle previously.

- *Interviewing buyers during their purchasing decision:*
  If attributes elicited are to be reflective of those that influence choices actually made, then it is desirable to sample new car purchasers as close as possible to the time at which their purchasing decision is made. This sample group are more likely to be able to identify those attributes that influence their new car buying behaviour. Furthermore, the sample's elicited attributes will not be influenced by the problem of cognitive dissonance as described above.

The third of these three sample types was considered the most appropriate for this research. In order to attain this sample, intending new car buyers were interviewed at car showrooms in the Colchester and Ipswich areas.

4.5.2 Sample Size

Saunders et al (2000) suggest that given the large number of influencing factors associated with the choice of sample size (for example the margin of error that can be tolerated, the types of analyses that are to be undertaken, and the size of the population from which the sample is drawn), *'the final sample size is almost always a matter of judgement rather than calculation'.*

A commonly quoted rule of thumb with regard to the minimum sample size for meaningful statistical analyses is 30 (Saunders et al, 2000). However this research aims to replicate stated preference best practice and so adopts higher sample sizes in line with previous pre-stated preference field research previously published. Whilst research reported by Green and Srivinsen (1979) relied upon sample sizes as low as 30, research studies by Nelson (1992, 1998) used sample sizes of 40 and 60 individuals in the attribute elicitation research prior to two different stated preference experiments. No further evidence of sample sizes for this type of research has been identified from literature, and so Nelson's higher (1998) sample size level was adopted for this research. As such as sample size of 60 was used.

4.5.3 Implementation of the Interviews and Identification of the Sample Group

The interviews for this pre-stated preference research, were implemented on Saturdays and Sundays during April 2000. Interviews were undertaken at weekends, because the showrooms reported highest number of sales during these periods.

As reported previously (section 4.4), information relating to the respondents age and sex were collected in the first stage of the interviews. Figure 9 presents the breakdown of the sample in terms of this demographic data. As can be seen the sample was found to represent both male and female respondents, although fewer women were included in the higher age categories of 50-60 and 60+. Respondents between the ages of 30 and 50 were also identified as representing the majority of new car buyers interviewed.

As previously discussed (section 4.4), this demographic data was collected to ensure that the pre-stated preference research sample represented a similar breakdown of individuals as those in the stated preference sample group. This comparison is made later in the thesis during the discussion of the analysis of the data collected during the stated preference experiment (section 6.2).

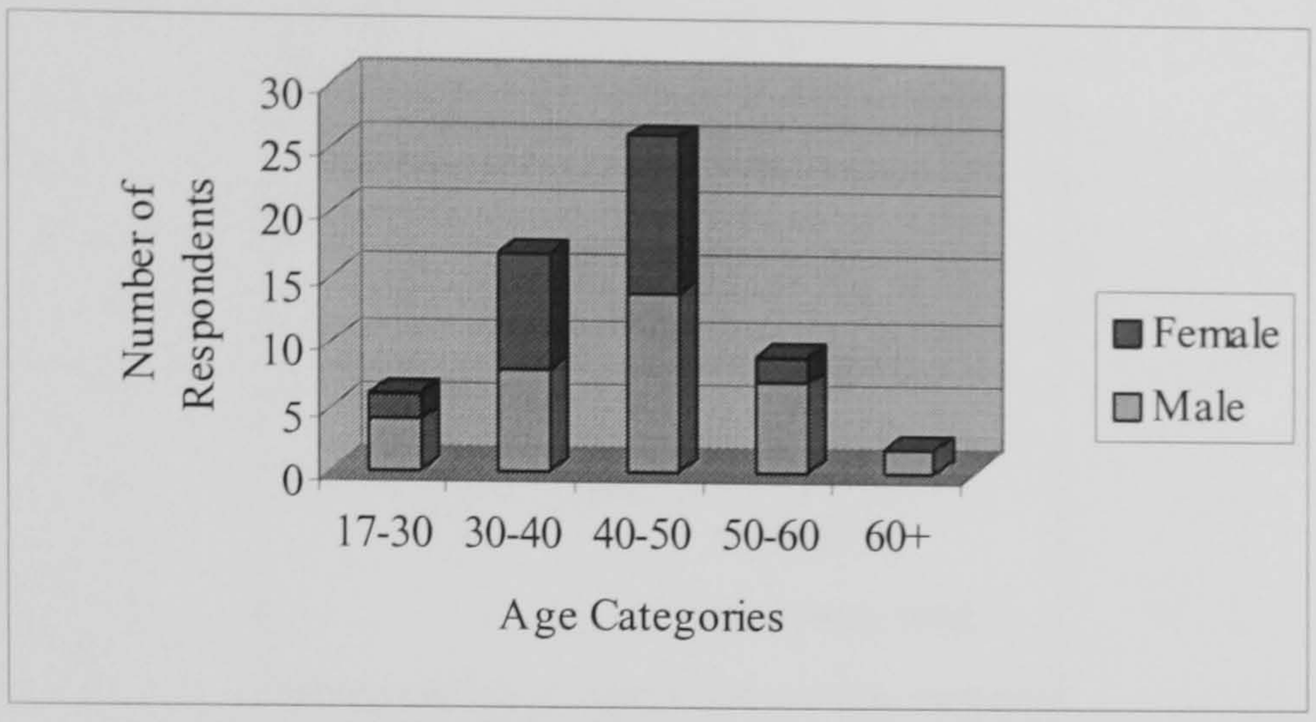


Figure 9: Demographics of Sample

The following section examines the analysis and coding of the interview data.

4.6 Analysis and Coding

4.6.1 Data Analysis – Eliciting and Understanding Respondent's Attributes

To provide an understanding of the data that is collected from the interviews with new car buyers, this section provides an example taken from one respondent.

In the initial part of the interview, the respondent cited six factors as influencing his choice to purchase a particular type of new car. These factors are presented in the order that they were elicited, and are referred to here as 'base salient attributes.

- Brand
- Diesel engine
- Price
- Car type
- Number of doors
- Conventional Looking

Each of these attributes was examined more closely, using the cognitive mapping technique, previously explained. Figure 10 shows the underlying attribute structure relating to the elicited attribute 'diesel engine'. The respondent was asked to explain how a diesel engine influenced their intention to buy a particular car. The respondent suggested that when comparing petrol and diesel cars, that a diesel car would exhibit a higher purchase price, greater fuel efficiency, a higher resale value, a higher level of noise from the engine, reduced acceleration, and a lower maximum speed.

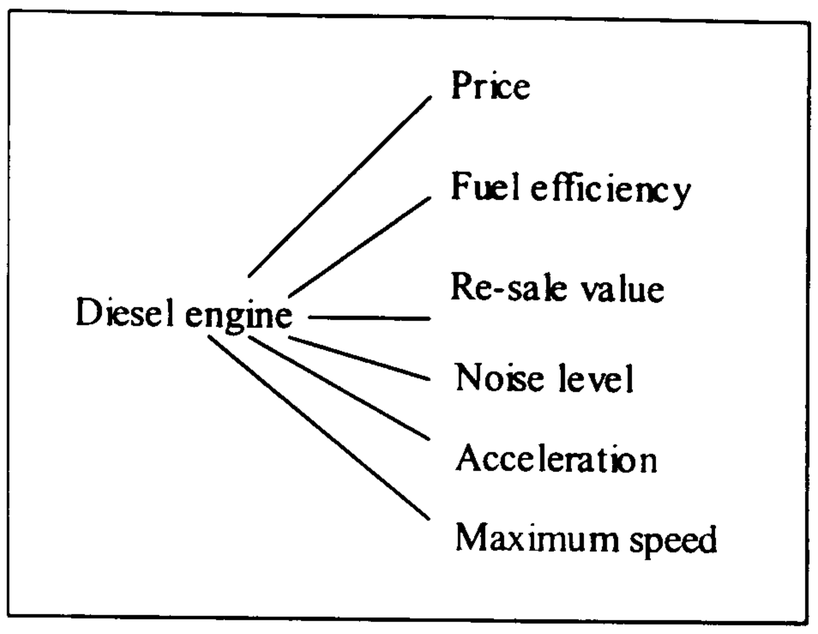


Figure 10: Related Attributes to 'Diesel Engine'

When then asked to explain each of these related attributes, the respondent stated further related attributes. For example, figure 11 shows that this respondent related price not only to fuel type, but also to brand and quality. This clearly shows the highly interrelated nature of the attributes relating to this individual's intention to purchase a particular type of car.

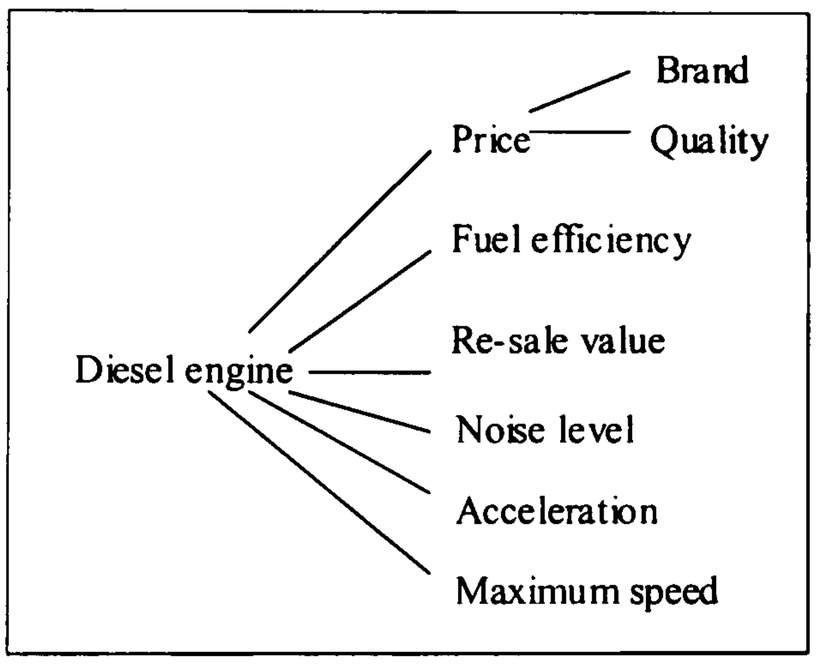


Figure 11: Related Attributes to 'Price'

This process continued until all elicited base attributes had been examined with the respondent. The elicited attributes and maps were then reviewed by the researcher with the respondent, to ensure that the correct interpretation of the meaning of the base attributes had been understood by the researcher.

This process uncovered a rich description of the underlying the 'base salient attributes' of respondents about their intention to purchase a car. This aided the researcher in the coding of responses, when the data from many individuals needed to be aggregated. In this particular case, whilst the respondent cited as a attribute 'diesel engine', it was possible to code this attribute as 'fuel type', when responses were aggregated with other data. The aggregation of attributes, to produce 'modal salient attributes is discussed further in section 4.6.2.

Further discussion of the interrelation and meaning of attributes by respondents is provided in section 4.7, where the selection of attributes for use in the stated preference experiment is discussed.

4.6.2 Determining Modal Salient Attributes

Different individuals have different salient attributes about any given behaviour. However, it is necessary to determine a set of salient attributes that represent all the respondents' elicited attributes that can be included within the stated preference experiment. Nelson (1992) states that *'the frequency of response of each attribute must be noted, and generally identifies clearly dominant sets of modal salient attributes.'* Tuck (1976) suggests that the modal salient attributes to be used in a second stage of research must account for 60% of all recorded responses.

By recording the frequencies of the carefully coded base salient attributes of individuals, as discussed in the previous section, it is possible to determine a set of modal salient attributes as described by Tuck (1976). Table 3 shows the modal salient attributes that new car buyers hold about their decision to purchase a new car. Included within the table are the relative percentage of total frequency scored by each identified attribute. The table represents those attributes that make up almost 60 percent of attributes stated.

Table 3: Modal Salient Attributes

Attribute	**% of total frequency score**
Appearance	12.27%
Size	11.24%
Brand	10.12%
Car type (eg saloon)	7.41%
Space inside the car	5.18%
Price	4.94%
Number of doors	4.78%
Fuel type	3.98%
	59.92%

The following section discusses the use of these attributes within a stated preference experiment, given the underlying meaning of the attributes, and the attributes of the study context (the Aerostable Carbon Car).

4.7 Selection of Attributes for the Stated Preference Experiment: Understanding the Research Context

Section 4.2 suggested that in order to allow a realistic estimation of an individual's utility function it is essential that the attributes portrayed in a stated preference experiment represent the attributes that customers consider to be salient in their purchasing choice. The previous section presented the modal salient attributes determined from the aggregation of attributes elicited from each individual. These are to be used to inform the design of a stated preference experiment. However the underlying meaning of these modal salient attributes must be more closely examined

in line with the choice context being examined before they can be included as attributes within the stated preference experiment.

Section 4.6.1 described the cognitive mapping process undertaken to provide the researcher with further understanding of the underlying meaning of the elicited base salient attributes. A summary of the attributes that individuals associate with the modal salient attributes is presented in table 4. It is clear that the innovative design of the Aerostable Carbon Car (the ASCC) contradicts some of the underlying associations made between attributes by new car buyers. For example table 4 shows that 'fuel type' is commonly related to fuel efficiency. Respondents who stated this relationship, such as that described in section 4.6.1 believed diesel cars to be more fuel-efficient. The ASCC however, designed to be a fuel-efficient vehicle, is powered by a petrol engine. It is important therefore that the ASCC is not mis-interpreted within the stated preference experiment.

Furthermore, the market research for the ASCC (the context of this research) aims to measure the value of improvements to fuel efficiency within new car buyers' purchasing intentions. Whilst fuel efficiency was not elicited as a salient attribute, it was frequently cited as the main difference between cars of different fuel type. It is therefore considered very important that this attribute be included, along with the other modal salient attributes, in the design of the stated preference experiment. Further discussion of the selection and presentation of attributes within the stated preference experiment are presented in the next chapter of this thesis.

Table 4: Underlying Associations Between Modal Salient Attributes

Salient Attribute	Related Attributes
Size	Maximum speed Safety Comfort Space inside the car Appearance Carrying capacity Ease of parking
Appearance	Old versus new styling Wheel type (eg alloy) Shape of lights Number of doors Image
Car type (eg. Saloon)	Ease of parking Carrying capacity Shape 'Family orientated' Image
Price	Brand Quality Fuel type
Brand	Parts availability Quality Reputation Reliability Safety Re-sale value Price
Number of doors	Appearance Image 'Family orientated' Practicality
Space inside car	Legroom Comfort Carrying capacity Size of car
Fuel Type	Price Re-sale value Noise levels Fuel efficiency Acceleration Maximum speed

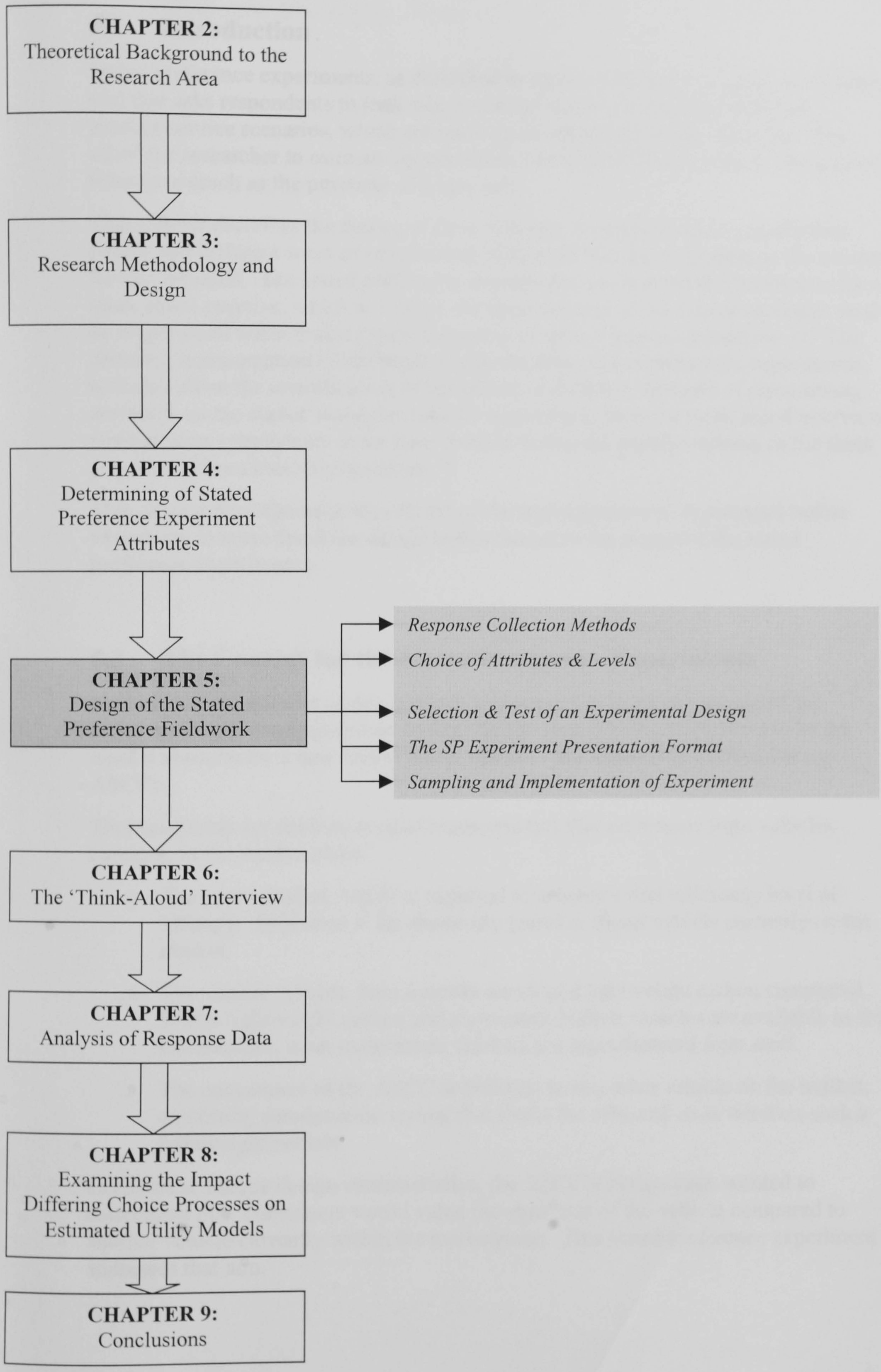
4.8 Summary and Conclusions

This section has described the need to elicit consumers' salient attributes about the purchase of a new car, in order to inform the decision of what attributes should be included within the stated preference experiment. The free response method was used to elicit salient attributes from new car buyers at showrooms, during their purchasing decision making process. This process produced the following modal salient attributes:

- Appearance
- Size
- Brand
- Car type (eg saloon)
- Space inside the car
- Price
- Number of doors
- Fuel type

Elicitation of consumers' underlying meanings of these attributes, using cognitive mapping, found that fuel type was frequently related to fuel efficiency levels – with diesel cars being considered far more fuel-efficient. The ASCC is a petrol car, with a high fuel-efficiency level, and so contradicts consumers' attributes. An additional attribute of fuel efficiency is therefore included within the experiment. The choice of attributes for inclusion within the stated preference experiment, based on these results is described in the next chapter of the thesis.

CHAPTER 5: THE DESIGN OF THE STATED PREFERENCE FIELDWORK


CHAPTER 2:
Theoretical Background to the Research Area
CHAPTER 3:
Research Methodology and Design
CHAPTER 4:
Determining of Stated Preference Experiment Attributes
CHAPTER 5:
Design of the Stated Preference Fieldwork
Response Collection Methods
Choice of Attributes & Levels
Selection & Test of an Experimental Design
The SP Experiment Presentation Format
Sampling and Implementation of Experiment
CHAPTER 6:
The 'Think-Aloud' Interview
CHAPTER 7:
Analysis of Response Data
CHAPTER 8:
Examining the Impact Differing Choice Processes on Estimated Utility Models
CHAPTER 9:
Conclusions

5.1 Introduction

Stated preference experiments, as described in earlier chapters, are a type of research tool that asks respondents to rank rate or choose between a series of different product/service scenarios, which are made up of alternative attribute mixes. They allow the researcher to estimate the consumer utility function associated with a given behaviour (such as the purchase of a new car).

This chapter describes the design of three different stated preference experiments (which use different ways of representing attributes) that are to be used as the context for this research. The stated preference experiments are to provide the stimulus for a think aloud exercise, which will allow the identification of the choice strategies used by respondents when making their choices in chapter 6 (*research question 1*). The differing representation of attributes within the three stated preference experiments, will also allow the identification of the effects of differing methods of representing attributes on the choice strategies used by respondents from the think aloud interviews conducted as respondents make their choices during the implementation of the think aloud interviews (*research question 2*).

This chapter first discusses the context of the stated preference experiment before examining in more detail the design issues related to the design of the stated preference experiments.

5.2 The Context for the Stated Preference Experiments

In chapter 3, the context of this research was presented in the discussion of the research design. An appropriate context for the research was considered to be the market research for a new fuel-efficient vehicle - the Aerostable Carbon Car (or ASCC).

The Aerostable car exhibits several characteristics that set it apart from vehicles currently in the market place:

- The petrol fuelled ASCC is expected to achieve a fuel efficiency level of 120mpg. This level is far above any petrol or diesel vehicle currently on the market.
- The vehicle is made from a newly developed lightweight carbon compound. Whilst lightweight carbon and aluminium-bodied vehicles are available in the marketplace, most mainstream vehicles are manufactured from steel.
- The appearance of the ASCC is different to any other vehicle on the market, exhibiting aerodynamic styling that limits the effect of cross wind on such a lightweight vehicle.

Given these unique design characteristics, the ASCC's design team wanted to understand how consumers would value the attributes of the vehicle compared to another vehicle currently within the marketplace. This stated preference experiment addresses that aim.

5.3 Response Collection Method

Stated preference techniques refer to types of experiment where individuals are asked to state how they would respond to different scenarios. There are several methods that can be used in the design of a stated preference experiment. Respondents may be asked to rank options, rate options on appropriate scales, or choose one option from a pair, or group of options (Pearmain et al., 1991). These alternative methods of presenting stated preference experiments are discussed in the following sections.

5.3.1 Rank options

In this type of stated preference experiment, the respondent is presented with a number of different scenarios representing a product or service. They are asked to rank them in order of preference. This ranking by the respondent will *'imply a hierarchy of utility values'* (Pearmain et al, 1991). Pearmain et al. suggest that this approach to the presentation of a stated preference experiment is attractive because all the options are considered together. However, they do highlight the problem of respondent fatigue in this type of exercise, and suggest that there is a limit to the number of options that can be presented to the respondent. Louviere et al (2000) support this criticism, stating that *'task difficulty increases substantially with the number of options to be ranked'*. Louviere et al also present further criticisms of this form of stated preference experiment presentation:

- Response reliability is likely to be affected by the number of options ranked and the degree of preference for each. That is, reliability should decrease with more options. Reliability should be higher for the most liked and disliked options, and should be lower for the options in the middle.
- The reliability and validity of information about the ranking of options that would never be chosen in any foreseeable circumstances is not clear.
- The reliability and validity of information about the ranking of options that either are not known, or are not well known to the consumer, is not clear.

5.3.2 Rate options on a response scale

This type of exercise asks respondents *'to express the strength of their preferences on numerical or "semantic" scales'* (Pearmain et al, 1991). For example, a respondent is presented with a number of alterative products/services. They might be asked how they would rate each of these options against a scale of 1 to 7, where 1 is very poor and 7 was very good.

Pearmain et al (1991) suggest one of the main benefits of this type of stated preference presentation is that the responses made provide both the order of a respondent's preferences, and also the strength of those preferences. Pearmain et al. state that *'Potentially this approach provides the richest source of response data, if one can assume that the scores are cardinal in measurement'*. Louviere et al (2000) however state:

> *'In this case, we must assume that consumers can provide a reliable and valid measure of their degree of preference for each option. Different response methods may be used depending upon one's attribute about consumers' abilities to report degrees of preference differences in options, option preference ratios etc. It is important to note that the latter constitute very strong assumptions about human cognitive abilities'.*

Pearmain et al (1991) also state, that the:

> *'Power of the technique improves with the fineness of the scale used. Some studies have used scales as large as 1 to 100 but such a scale is of little use if respondents cannot make judgements to the same degree or precision'.*

5.3.3 Choice-Based Methods

As well as the criticisms highlighted in the previous sections, Pearmain et al (1991) also suggests that the two types of stated preference experiment described, suffer from a lack of realism. Neither of these types of experiment reflects the way in which consumers make real life decisions. Referring specifically to ranking exercises (described in section 5.3.1), Pearmain et al state:

> *'The researcher needs to be aware that the data provided by this method* [ranking methods] *represent judgements by respondents, which do not necessarily correspond to the kind of choices they face in real life. This is also a problem with rating responses'*

Louviere (1988) also suggests that discrete choice present a more realistic judgement by the respondent:

> *'One can design choice or allocation experiments to mimic real choice environments closely. This is important because individuals in real environments do not rank or rate travel alternatives; they choose one of them, or they choose not to choose any alternative'.*

It is partly due to these criticisms that Pearmain et al (1991) suggest that discrete choice exercises have become so popular since Louviere and Hensher (1982) published the first example of a stated preference experiment that incorporated choice experiments. In this type of stated preference experiment, the respondent is presented with a choice between two or more different options. They are asked to choose the option they would be most likely to buy. These choices can be made on a scale, representing probability of choosing a particular option.

Presenting differing options in paired comparisons, which the respondent chooses between, are considered particularly useful because they allow preferences to be expressed easily. This type of experiment is now considered the most commonly used form of stated preference experiment (Pearmain et al, 1991). It is for this reason that this type of experiment is adopted for this research.

5.3.4 Application of Choice Based Stated Preference

In the previous section, it was stated that this research adopted the paired comparison form of stated preference techniques. To apply this technique within this research, the respondent was presented with a paired comparison, comparing the attributes of the ASCC to those of another car. As this research is interested in how the ASCC would be compared in the actual market place for new cars, it seems appropriate that the car used for comparison be one that currently exists in the market place.

A suitable brand of car against with which to compare the ASCC is that of Volkswagen. Within the VW range exists the Lupo, which is currently one of the most fuel-efficient vehicles on the market reaching levels of 82 mpg for the diesel version (Volkswagen, 2002). The vehicle used for comparison against the ASCC however was the Volkswagen Golf. The Volkswagen Golf is (unlike the Lupo) available in 3 and 5 doors models, which is an important requirement of the experiment, as number of doors is to be included as a attribute (see section 5.4.2 for further discussion of attribute selection).

In order to reduce the likelihood of brand bias during the stated preference experiments, the ASCC was described as a Volkswagen when it was compared with the Volkswagen Golf. Further discussion of the selection of attributes and their levels, and the statistical design of the experiment, are presented in the following sections.

5.4 Design of the Stated Preference Experiment

5.4.1 Steps in the design of a stated preference experiment

Within the design of a states preference experiment, the researcher is faced with a number of decisions that must be made. Hensher (1994) presents a number of key steps in the design of a stated preference experiment:

- The identification of attributes;
- The specification of the number and magnitude of attributes;
- The selection of a statistical design;
- The translation of the design into a set of questions and show cards; and
- The selection of an appropriate estimation procedure.

Nelson (1998) suggests that in addition to these elements, the researcher needs also to include a seventh element in the design process that determines how the attributes are represented within the stated preference experiment (also referred to as 'stimulus presentation' by Green and Srinivasan (1979).

Whilst these different elements of the design phase are listed separately, in reality these decisions are very much interlinked. Louviere et al (2000) suggest that the design of a choice based experiment should aim to present 'market realism', which

they describe as referring to *'the degree to which the experiment and associated task match the actual decision environment faced by subjects'*. This realism achieved within the experiment presentation, is affected by: the attributes used, their measurement units, the number and magnitude of attributes, and the way in which these attributes are represented to the respondent. However, increasing realism of the task facing the respondent can affect the cognitive complexity of the experiment. Louviere et al (2000) suggest that this *'refers to the degree of task complexity and difficulty arising from the experiment'*. Limiting the complexity of the experiment has implications for the number of attributes and their levels, the number of choices presented to the respondent and so the statistical design adopted.

These design choices are discussed in the following sections.

5.4.2 Choice of Attributes

The choice and description of attributes and the level of attributes is critical to the success of a stated preference experiment. The level of an attribute refers to the value of an attribute. For example, differing prices of cars of £8,000, £12,000 and £18,000 would represent three differing *levels* of the *attribute* 'price'. Pearmain et al. (1991) suggest that the following points should be considered when selecting attributes and attribute levels:

- Attributes and levels should appear plausible;
- They need to relate to the respondent's experience of each attribute

Chapter 4 of this report described research undertaken to determine the attributes that influence the decision of new car buyers to purchase a particular type of new car. These identified attributes were those that informed the decision-making process of the new car buyers interviewed in the pre-stated preference research. By using attributes elicited from new car buyers in the stated preference experiment it is possible to ensure that attributes are plausible and relate to respondents experiences (as suggested by Pearmain et al., 1991)

The attributes associated with the purchase of a new car were presented in section 4.8, in chapter 4. The decision whether to include each of these as attributes in the stated preference experiment are discussed below:

- *Size:* The market for new cars is extremely segmented. One segmentation of the market is in terms of car size. Most car manufacturers have a range of cars of differing sizes and types in order to appeal to different new car buyers. As the design of the ASCC restricts changes to its overall size, this attribute was not included as an attribute with varying levels in the experiment. Any difference in size between the two cars therefore remained constant, and the difference in any consumer utility is represented in the intercept term of any utility model.
- *Appearance:* Differences in overall appearance design cannot be measured as a continuous variable. Whilst there is a marked difference in the appearance of the ASCC and the car used for comparison in the experiment, it was decided that the attribute would not be included as one of the attributes with varying levels. As with *size*, differences in consumer utility for the *appearance* of the two cars will be reflected in the intercept term of any utility model.

- *Car type and brand*: Car type and brand were held constant in the experiment, in order to reduce the number of attributes included in the experiment (and the subsequent number of choices presented to the respondent, which is discussed later in the experiment). In each pair wise choice presented in the experiment, both cars were described as being of the same brand. The ASCC was therefore described as a Volkswagen. All cars used in the experiment were hatchbacks

- *Space inside the car:* When space inside the car was described as a factor considered by respondents, it was considered highly related to the overall size of the car. As such, this attribute was treated in the same way as *Size* and not included as a variant within the experiment.

- *Price:* This was included as an attribute in the stated preference experiment. Price is commonly included within stated preference experiments because it allows monetary valuation of attribute weighting during the analysis of the stated preference data.

- *Number of doors:* Number of doors was also included as an attribute in the experiment. As the ASCC design is fixed however (with 3 doors), it was considered suitable for the comparison car to represent changes in the number of doors.

- *Fuel type:* In the pre-stated preference research described in chapter 4, respondents often related diesel cars with fuel-efficiency. It was considered important that the fuel type of the cars in the stated preference experiment was included as an attribute. If this attribute had not been included, a car represented as fuel-efficient may otherwise have been assumed to be diesel.

Other attributes of particular interest to the designers of the ASCC, which were not highlighted as salient attributes in the earlier study, were also included in the stated preference experiment. The reasons for their inclusion are given below:

- *Fuel efficiency:* The ASCC was designed to maximise fuel efficiency. Whilst this attribute was not specifically highlighted as salient attribute in the pre-stated preference research, it was related to the salient attribute *fuel type* (where diesel cars were equated to fuel-efficiency. Projected fuel efficiency of the ASCC (120 miles per gallon) is also far higher than any car currently on the market. It was considered of particular interest to understand consumer preferences for fuel efficiency levels at these previously unavailable levels.

- *Body Type:* The ASCC achieves high projected fuel efficiency levels because it is constructed from an extremely lightweight carbon compound. Given this material is unusual in the construction of mass produced cars, it was included in the experiment, to test consumer utility weighting for it.

5.4.3 Attribute levels

The researcher of a stated preference experiment needs to decide upon the number of attribute levels to be included, and also the values of these attribute levels. The number of attribute levels to be included in a experiment impacts on the complexity of the experiment being presented to the respondent. To limit the complexity of the experiment therefore, the researcher would also want to limit the number of levels presented for each attribute. However *"For attributes of particular interest to the researcher, more than two levels are advisable"*, (Pearmain and Kroes, 1990). Pearmain et al (1991) suggest that this is particularly important when responses to attributes may be non-linear. Figure 11 depicts an illustration of a non-linear effect. This depicts the response made (relating to one of the options within the choice scenario), against changes in one of the attributes relating to the options in the choice scenario.

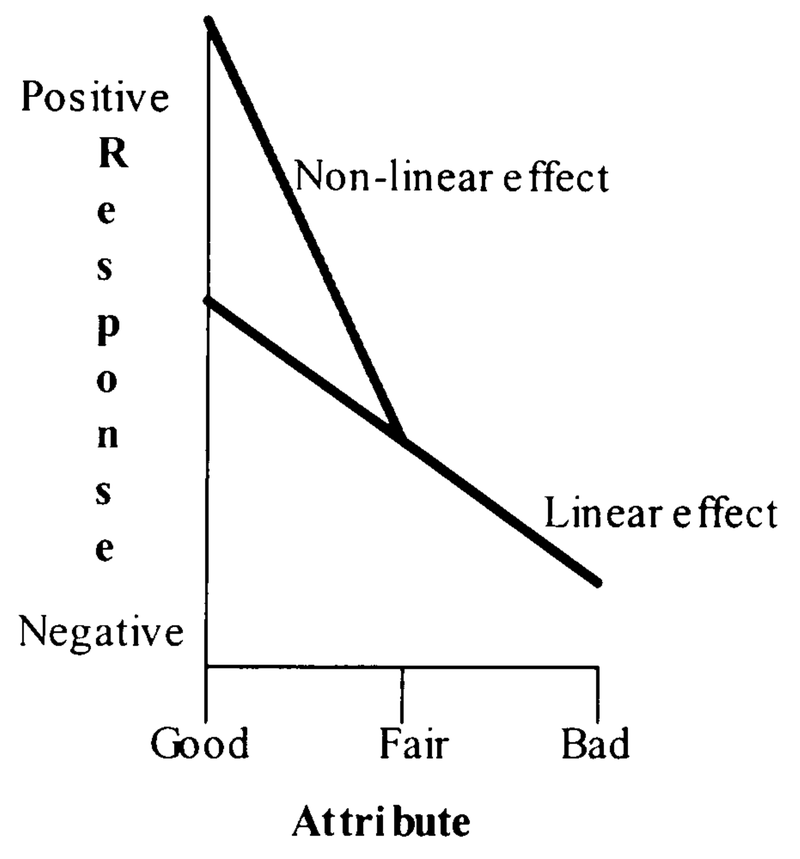


Figure 12: Illustration of a Non-Linear Effect in Response (Pearmain et al, 1991)

In the example provided in figure 11, the move from 'bad' to 'fair' has about half the effect as a move from 'fair' to 'good'. When a non-linear effect such as this exists, alternative utility models maybe appropriate than one that that is linear and additive. Pearmain et al (1991) suggest:

> *'The issue of alternative model forms is important, because many studies fail to explore this issue, preferring instead to use simple linear models. Only when attributes of more than two levels are used can a full range of alternative models be examined'.*

Within the stated preference design for this research therefore, three levels are used for the attributes of price and fuel-efficiency.

Attributes, and their attribute levels, should, where possible reflect 'market realism' (Louviere et al, 2000). Ortuzar and Willumsen (1994) also highlight the importance

of using existing and perceived levels of attributes so that options are built around existing experience. This suggests that the attributes of the vehicles presented in the stated preference experiment should reflect those that are available within the market place. However, stated preference techniques are commonly used to measure how consumers value new products and attribute levels (Pearmain et al, 1991), and these may not be currently available within the marketplace. Therefore the attributes included within the stated preference experiment, which aims to measure how consumers value the attributes of the Aerostable Carbon Car (ASCC), include realistic market values *and* those attributes relating to the ASCC.

As well as attempting to present realistic attribute levels, Pearmain et al (1991) also highlight the need for attribute levels to cause respondents to trade-off attributes in their decision making process. They state:

- The values attached to attributes should ensure that competitive trade-off decisions are presented;

- The values attached to attributes should present trade-offs that cover the range of valuation held by each respondent.

In the design of the stated preference experiments used within this research, attribute levels that reflected market conditions were included where possible. The levels for each of the attributes included within the experiments are now each discussed in turn. The attribute levels for the price of the ASCC were set at values, which compared with the price of the Volkswagen Golf (the comparison car is the pair-wise choice), and reflected the range of prices available for small cars within the market place. Attribute levels of £8,000, £12,000 (the price of the Volkswagen Golf), and £18,000 were therefore selected. These prices reflected the low medium and high price levels of a small/medium-sized vehicle within the market place.

The fuel-efficiency attribute also included levels that reflected the levels within the market place, but also of that of the projected level of the ASCC. Therefore levels were set at 40mpg (the level of a petrol fuelled Volkswagen Golf), 65 mpg (the level of a diesel fuelled Volkswagen Lupo), and 120mpg (the expected fuel efficiency of the ASCC). Whilst the fuel efficiency level of the ASCC does not currently exist within the market place, it was hoped that this level would be accepted as plausible by respondents presented with a newly developed vehicle.

The other attributes included within the stated preference experiment did not represent continuous data variables. Three attribute levels were set for the attribute 'body type' (steel, carbon or aluminium), because an understanding of consumer's valuation of this attribute was specified as one of the aims of the ASCC's designers. Two levels were set for the attributes number of doors (3 or 5) and fuel type (petrol or diesel) reflecting levels currently found within the market place.

In addition to the varying attribute levels discussed above, the experiment also includes the attribute vehicle appearance, which exists as a constant value. In other words, the appearance of each of the two vehicles in the pair-wise choice is included within the experiment design, as a constant difference.

A summary of the attributes and the attribute levels included within the stated preference experiment are presented in table. Careful piloting of the stated preference experiment using the attribute levels presented in table 5 was carried out with new car

buyers at new car show rooms. This pilot identified that trading occurred with attributes presented at these levels.

Table 5: Attributes and their levels

Attribute	Level 1	Level 2	Level 3
Price (of ASCC)	18,000	12,000	8,000
Body type (of the ASCC)	Steel	Carbon	Aluminium
Fuel efficiency (of ASCC)	40 mpg	65 mpg	120 mpg
Number of doors (of comparison car)	3	5	
Fuel type ASCC	Petrol	Diesel	
Vehicle appearance (Difference between 2 vehicles is constant)			

5.4.4 Selection of an Experimental Design

The previous sections have identified the attributes, and the number of attribute levels to be included within the stated preference experiment. With the attributes and their levels decided, it is possible to construct the experimental design of the experiment itself. When all possible attribute combinations are presented to the respondent, this is known as a full factorial design. Pearmain et al (1991) state that:

> *'It* [a fully factorial design] *ensures that the attributes presented to respondents are varied independently from one another. The result is that each attribute level upon responses are more easily isolated'.*

Factorial designs of stated preference experiments are attractive to researchers because the variation of each of the attributes is independent. A design that exhibits this independence of variables is often termed 'orthogonal'. Watson et al. (2000) state that:

> *'As it is well known that correlation between attributes inflates standard error estimates for given sample size, much design advice has been to use orthogonal designs so that there is no such correlation'.*

However, despite this and other literature describing the statistical attractiveness of this type of design (eg. Fowkes et al., 1993), a factorial enumeration of all possible combinations of attribute levels can lead to a very large number of choices being presented to a respondent. Given the attributes and attribute levels (summarised in table 6) to be included in this experiment, a fully factorial design would result in 36 choice tasks being presented to each respondent.

Attribute	Number of Levels
Price (of ASCC)	3
Body type (of the ASCC)	3
Fuel efficiency (of ASCC)	3
Number of doors (of comparison car)	2
Fuel type ASCC	1

Table 6: Attributes and the Number of Levels

This is calculated as follows:

3 attributes at 3 levels = 3^3 = 9

2 attributes at 2 levels = 2^2 = 4

Total number of alternative = 9 x 4 = 36 choices

Kroes and Sheldon (1988) suggest that a respondent should be presented with no more than 16 choices and Pearmain et al. (1991) reinforce this suggesting that more than this number of choices would result in respondent fatigue.

As a result of attempts to limit the number of choices presented to a respondent, whilst trying to achieve the statistical robustness of a full factorial design, considerable research effort has been focused on the development of alternative experimental designs. Literature relating to these alternative designs and their statistical properties and their validation include: block designs, adaptive designs, and fractional factorial designs.

In a block design, choice options are separated into blocks, so that the full choice set is completed by groups of respondents, each responding to a different sub-set of options (Pearmain et al, 1991). One of the main criticisms of this type of design is that it assumes that preferences across the samples of respondents can be combined over the subsets of options. Pearmain et al (1991) suggest that *'Inevitably, differences between individuals will increase the error associated with the results'.*

An adaptive design is a type of experiment that is implemented during the interview process on a computer. The choices presented to the respondent are adapted during the interview process, focusing on attribute levels near the respondent's estimated trade-off points (see Sawtooth Software, 1996; Green and Krieger, 1991; Green and Srivinson, 1990; Huber and Hanson, 1986; Johnson, 1989). This approach has received significant criticism relating to the assumptions that must be made about the statistical design of the experiment as a result of the adaptive nature of the design (for a full discussion see Bradley and Daly, 2000). Given that the experiment is adapted for each respondent, this approach also makes use of a number of different designs.

Fractional factorial designs use a subset of all attribute combinations (see Louviere et al. 2000; Pearmain et al., 1991; Fowkes and Wardman, 1988). This is the most commonly used solution because it allows the *'examination of appreciably larger numbers of attributes and levels, while still using only one experimental design'*. It is for this reason that this method of choice reduction was used for the design of the stated preference experiment in this research. This type of design makes the

assumption that some or all of the interactions between attributes are negligible. Significant interactions are those where two or more attributes are acting together have an effect different from the sum of their individual effects. An interaction between two attributes is illustrated in figure 12. This shows how an individual's response alters with changes in the combination of two attributes. As attribute 1 moves from a 'bad' level to a 'good' level, the response becomes more positive. When there is no interaction, response also becomes more positive when attribute 2 goes from a bad level to a good level, but the rate of improvement in relation to attribute 1 remains the same. When there is a positive interaction between the attributes, the rate of improvement due to attribute 2 is not the same in relation to attribute 1: the combined effect of both attributes being at a good level is greater than the individual effects.

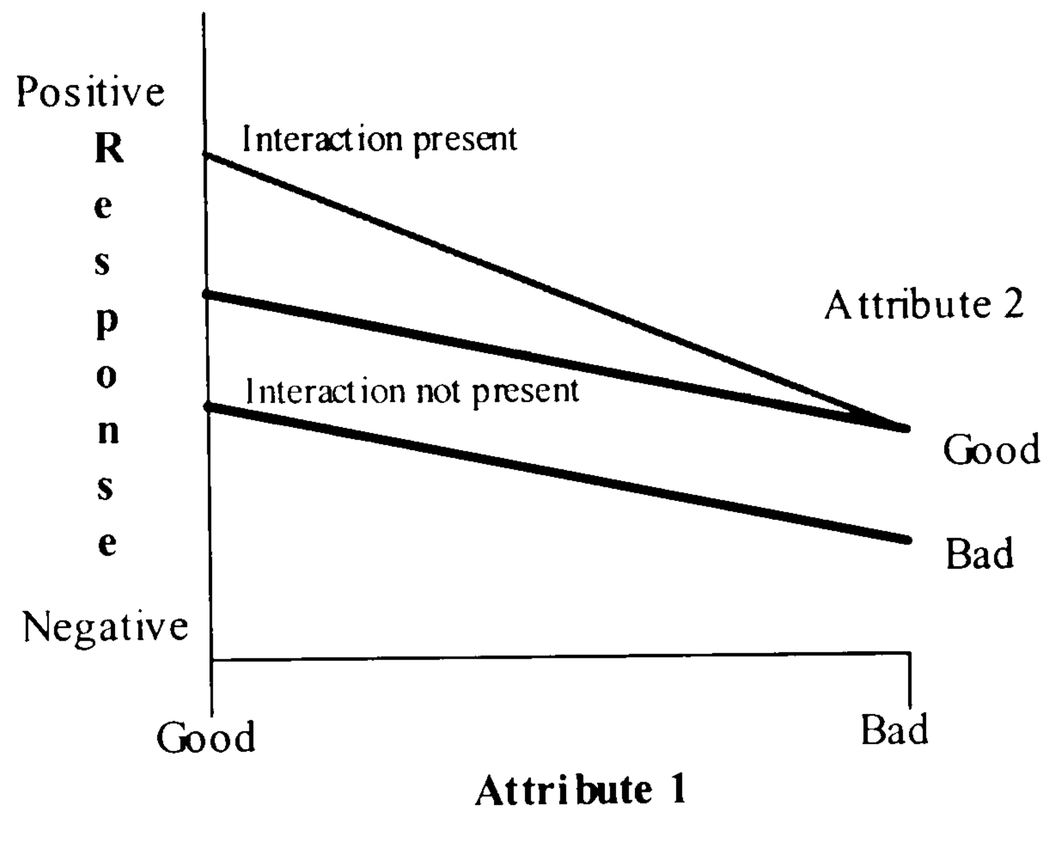


Figure 13: Illustration of an Interaction Effect Between Two Attributes (Pearmain et al, 1991)

A fractional factorial design for the stated attributes and levels was generated using the SPSS stated preference design module. For the attributes and levels for this research, this generates a total of 16 choice sets, which is within the range of 9-16 suggested by Kroes and Sheldon (1988), which was discussed earlier in this section. The experimental design produced from this fractional reduction of choices is presented in table 7.

A test to determine the level of correlation evident in this fractional design found only low levels of correlation. The correlation matrix for the fractional design used in this research is presented in Appendix E, depicting the correlation coefficients related to pairs of attributes. No strong correlations between attributes were identified, and the design was therefore accepted.

Table 7: Fractional Design

	Attributes				
Scenario no.	**Price of ASCC**	**Body Type of ASCC**	**Fuel efficiency of ASCC**	**No. of doors of comparison**	**Fuel type of ASCC**
1	18000	Carbon	65	3	Diesel
2	18000	Carbon	40	5	Petrol
3	12000	Aluminium	40	3	Petrol
4	8000	Steel	40	3	Petrol
5	8000	Steel	65	3	Petrol
6	8000	Steel	65	5	Petrol
7	8000	Steel	40	5	Diesel
8	8000	Steel	120	3	Diesel
9	18000	Carbon	120	5	Petrol
10	18000	Carbon	40	3	Diesel
11	8000	Steel	40	5	Petrol
12	12000	Aluminium	40	5	Diesel
13	12000	Aluminium	120	3	Petrol
14	8000	Steel	40	3	Diesel
15	8000	Steel	120	5	Diesel
16	12000	Aluminium	65	5	Diesel

5.4.5 Test of Experimental Design Using Simulated Data

Pearmain et al. (1991) suggests that the researcher must consider that: '*the attribute levels are close enough to each other to allow a sufficiently accurate estimate of the boundary values*'. Furthermore, they state that *'the way in which attribute levels are defined in stated preference experiments will influence the accuracy with which the researcher can model individual preferences*'. To aid the development of an efficient stated preference design, a simulation experiment was implemented to test the experimental design.

Pearmain et al. (1991) clearly present a protocol for testing how effective a stated preference design is in eliciting respondents' preferences. This protocol is described as a number of stages:

1. Create a set of artificial utility values representing the likely range of values possessed by the sample to be presented with the experiment.
2. Create responses to the stated preference design for each case of utility values created in stage 1.
3. Analyse the simulated response, just as one would with actual experiment data, to produce estimates of the artificial utility values.
4. Compare model estimates (implied utilities) against the original utility function assumed in step 1. If the ratios are significantly different from those assumed, alter design and repeat steps 2 to 4.

Following this protocol, a series of simulated trials of the stated preference design were carried out, using a range of assumed utilities for the different attributes. These assumed utility levels were determined from the estimation of utility weighting from

the stated preference response data collected from a pilot of the stated preference experiment (the analysis of the pilot response data is presented in Appendix F). The simulation results are also presented in Appendix F.

The results of the simulation show close comparability between the utility values implied and the simulated results for assumed utility levels close to those estimated in from the pilot experiment. This indicates that the model is effective within this band of utility levels that were tested.

Widening the narrow band of utility levels leads to a decrease in the ability of the design to model utility accurately. That is, the simulated estimates vary more greatly from the implied utility values. However, these levels of variance fall within levels accepted by Nelson (1992) in stated preference research that employed similar testing methods.

5.4.6 The Stated Preference Experiment Presentation

The fractional design presented in table 7 (section 5.4.4) was translated into show cards for use in the stated preference experiment. Respondents were asked to respond to a discrete choice between a Volkswagen Golf and the ASCC. One of the research questions (discussed in detail in section 1.4) was:

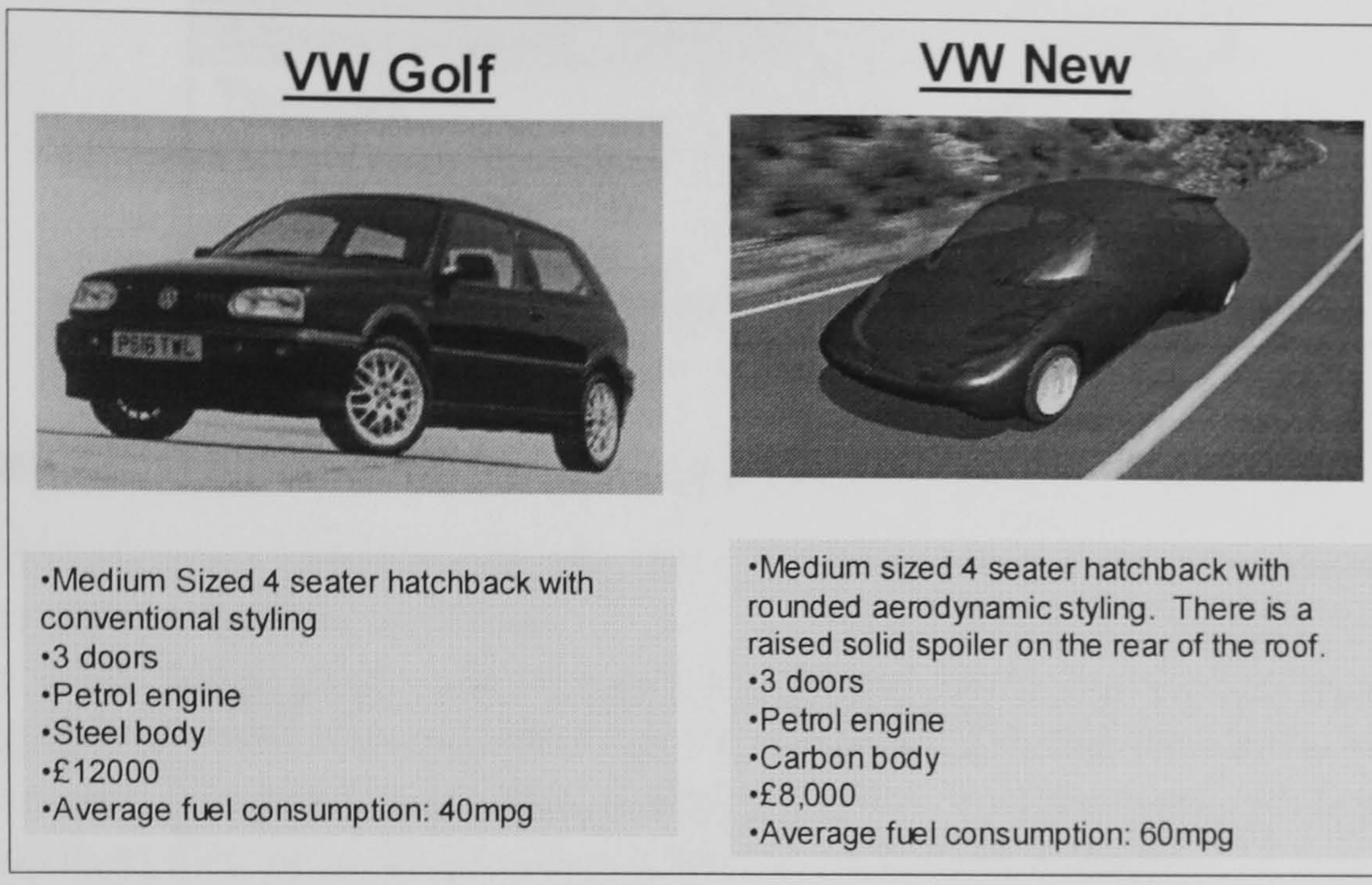
> *'Does the way in which attributes are presented (text or pictures) alter the choice strategy used by a respondent in a stated preference experiment?'*

Three different types of choice card were used in the experiment for three different sample groups, with the qualitative attribute 'appearance' represented by:

- Text only
- Pictures only
- Text and pictures

The textual representation of the attribute appearance was derived from discussions with new car buyers about the appearance of the ASCC at the end of the pre-stated preference data collection interviews (discussed in chapter 4). All other attributes were presented as text, with only the representation of the attribute 'appearance' changing between the sample groups. An example of a choice card showing the use of pictures and text is presented as figure 13. Other information obtained from each respondent during the stated preference exercise was age, and sex. These figures were obtained so that any differences between the samples used for each stated preference experiment, or with the sample used in the pre-stated preference research could be identified (as discussed in section 4.5). The fieldwork documents used during the stated preference experiments are presented in Appendix G.

Figure 14: An Example of a Text&Picture Choice Card



5.5 Sampling strategy

This section describes the identification of sample sizes needed in order to allow robust valuations of the consumer utility weightings associated with the attributes of the ASCC.

Sample sizes for stated preference experiments are generally small in comparison with other experiment methods. '*Stated preference experiments are statistically efficient in the sense that each interviewee produces not just one observation but several on the same choice context'* (Ortuzar and Willumsen, 1994). For example, a experiment of 20 respondents with 10 responses generates a set of 200 pieces of data. Kocur et al (1982) suggest that '*successful models have been built with as few as 30 respondents*'. Furthermore, Ortuzar and Willumsen (1994) state that *'an early rule of thumb seems to have stated that around 30 interviews per market segment might be sufficient.'*

The above literature suggests that a minimum of 20 respondents per experiment should be used in a stated preference experiment. Whilst each respondent can generate a number of pieces of information, a larger sample size of respondents is still considered by this researcher to be preferable. This research allows 40 interviews per stated preference experiment, which is above the minimum level suggested in the above literature. As discussed in the previous section, this research compares the ASCC with the Volkswagen Golf in three different stated preference exercises, with differing attribute representation. Table 8 below shows the sample sizes for each experiment, and the total sample size for the whole study.

Further discussion of the sample breakdown is provided in section 6.2.

Table 8: Stated Preference Experiment Sample Sizes

Representation of attributes	Sample size
Text only	40
Picture only	40
Picture and text	40
TOTAL SAMPE SIZE	120

5.6 Implementation of the Experiment

The stated preference experiments described in this chapter were carried out at new car showrooms in Suffolk and Essex in July to August 2000. As previously discussed in section 5.4.5, initial pilot experiments were carried out to ensure that consumers were making trade-offs between the choices, and therefore that the attributes were at suitable levels. This pilot found that trading occurred, and the stated preference design was therefore considered suitable for use in the main study.

The three stated preference experiments described in this chapter (that represent three different ways of representing the attributes presented), were used as the research context for a think-aloud interview, that aimed to identify the choice strategy used by respondents as the make their choices for each of the pair-wise comparison with which they are presented (research question 1). The implementation of think-aloud protocol, and discussion of how the alternative choice strategies were identified is described in following chapter – chapter 6.

5.7 Summary

This section has described the design of the stated preference experiment. It described the development of a pair-wise comparison experiment, where the ASCC is compared with a Volkswagen Golf.

Discussion of which of the cars attributes should be included within the experiment was discussed, based upon the evidence from the elicitation of consumer salient attributes (described in section 4) and the requirements of the ASCC's designers. The following attributes were therefore included:

- Price
- Number of doors
- Fuel type
- Fuel-efficiency
- Body type

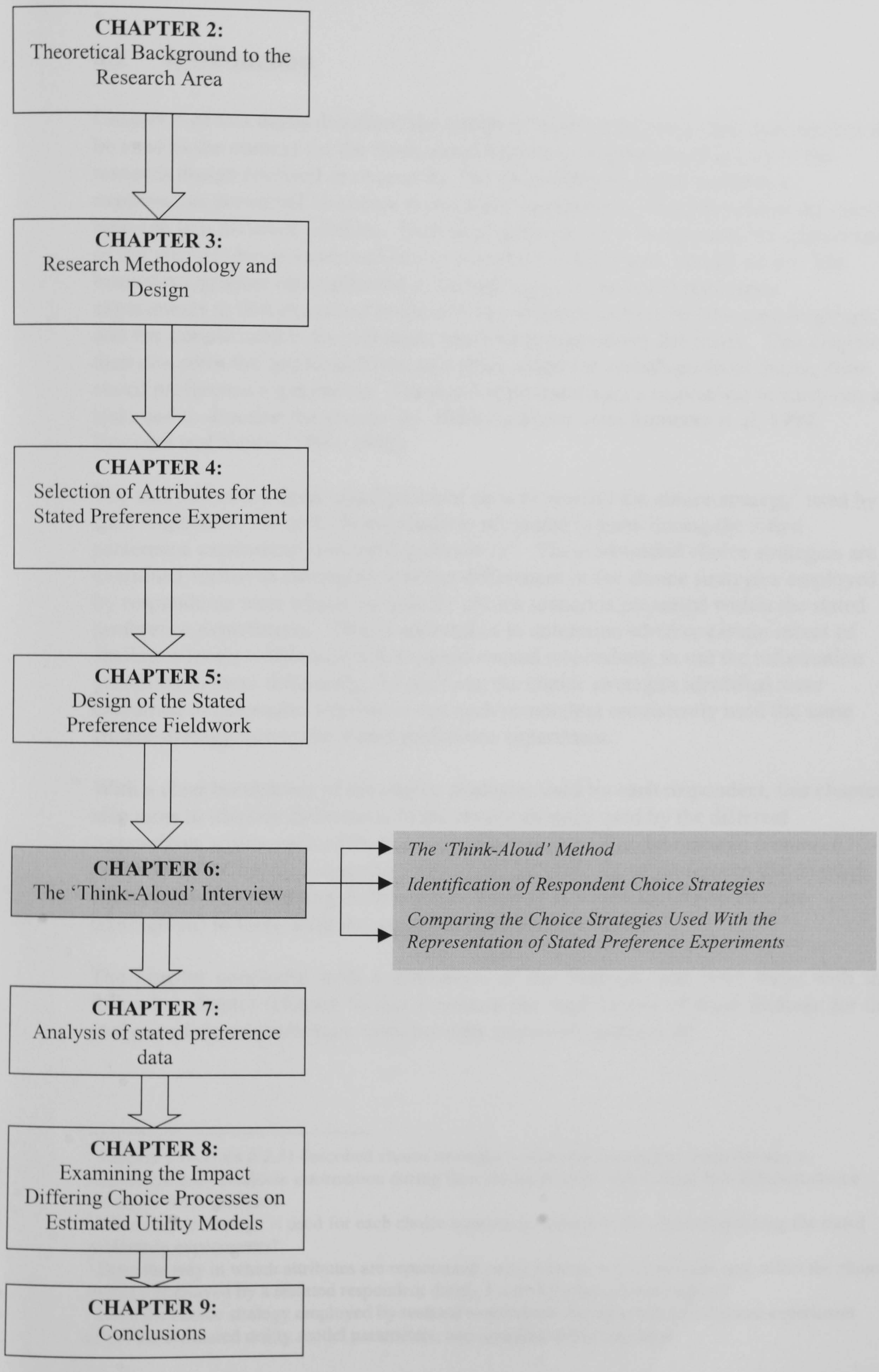
Attributes whose levels did not change, but remained constant during the experiment were:

- Appearance
- Size

A large number of attributes, such as those shown above, produce a large number of choice cards if a full factorial design were to be used for the experiment (in this case 36 choices). To reduce the number of choices presented to the respondent (and so reduce respondent fatigue) a factional design was employed which resulted in a stated preference experiment with 16 choice cards.

Three stated preference experiments were implemented, using three different methods of representing the attribute appearance: text, text and pictures, and pictures. These three experiments were implemented using think-aloud protocol. This implementation of the think-aloud protocol will now be discussed in chapter 6 of this thesis.

CHAPTER 6: THE 'THINK-ALOUD' INTERVIEW


CHAPTER 2:
Theoretical Background to the Research Area
CHAPTER 3:
Research Methodology and Design
CHAPTER 4:
Selection of Attributes for the Stated Preference Experiment
CHAPTER 5:
Design of the Stated Preference Fieldwork
CHAPTER 6:
The 'Think-Aloud' Interview
The 'Think-Aloud' Method
Identification of Respondent Choice Strategies
Comparing the Choice Strategies Used With the Representation of Stated Preference Experiments
CHAPTER 7:
Analysis of stated preference data
CHAPTER 8:
Examining the Impact Differing Choice Processes on Estimated Utility Models
CHAPTER 9:
Conclusions

6.1 Introduction

Chapter 5 of this thesis described the design of three stated preference experiments to be used as the context for the think-aloud interviews implemented as part of the research design (defined in chapter 4). The three different stated preference experiments presented 16 choice scenarios to respondents, which described the choice between two different vehicles. Each used different ways to represent the *appearance* of the vehicles being examined (using pictures, text&pictures, and pictures). The basic demographic data collected at the beginning of the stated preference experiments is first examined to identify any differences between the sample groups, and the sample used in the pre-stated preference experiment fieldwork. This chapter then describes the implementation of a think-aloud (or verbal) protocol during these stated preference experiments. Think aloud protocol asks a respondent to carry out a task, and to describe the process by 'thinking aloud' (van Someren et al, 1994; Ericsson and Simon, 1980, 1993).

The analysis of the think aloud protocol aims to identify the choice strategy[2] used by each respondent for each choice scenario presented to them during the stated preference experiment (*research question 1)*[3]. These identified choice strategies are examined further to determine whether differences in the choice strategies employed by respondents were biased by specific choice scenarios presented within the stated preference experiments. This is undertaken to determine whether certain mixes of attributes levels within a choice scenario caused respondents to use the information presented to them differently. In addition, the choice strategies identified were examined to determine whether or not each respondent consistently used the same choice strategy during the stated preference experiment.

With a clear breakdown of the choice strategies used by each respondent, this chapter also aims to identify differences in the choice strategy used by the different respondents within each of the three sample groups within the research (*research question 2)*[4]. Chapter 5 described how three different stated preference experiments were presented (reflecting differences in the way in which the attributes were represented) to three different sample groups of respondents.

The chapter concludes with a discussion of the findings, and links these with the following chapter (chapter 7) that considers the implications of these findings for the analysis of stated preference response data (*research question 3)*[5].

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[2] Chapter 2 (section 2.2.5) described choice strategies within this research to mean the way a respondent uses available information during their choice process, and defined five different choice strategies from literature.
[3] What choice strategy is used for each choice scenario presented to the respondent during the stated preference experiments?
[4] Does the way in which attributes are represented, using picture, text or picture&text, affect the choice strategy employed by a restated respondent during a stated preference experiment?
[5] Does the choice strategy employed by restated respondents during a stated preference experiment affect the estimated utility model parameters, and resulting utility estimates?

6.2 Sample Data

The three different stated preference experiments implemented as part of this research were presented to three independent samples within this research. This removed the potential bias relating to the order in which the experiments were presented to respondents. To ensure that similar sample groups were maintained information relating to the age and sex of the respondents within each of the groups was also collected, so that sample groups could be compared.

Figure 15 presents the distribution of respondent ages for each of the three sample used in this research (text, picture&text, and text) across 5 age categories. The breakdown of the three samples identified the 30-40, and 40-50 ages categories representing the largest number of respondents for all three samples. This is also consistent with the ages of the respondents included within the pre-stated preference fieldwork (explained in chapter 4).

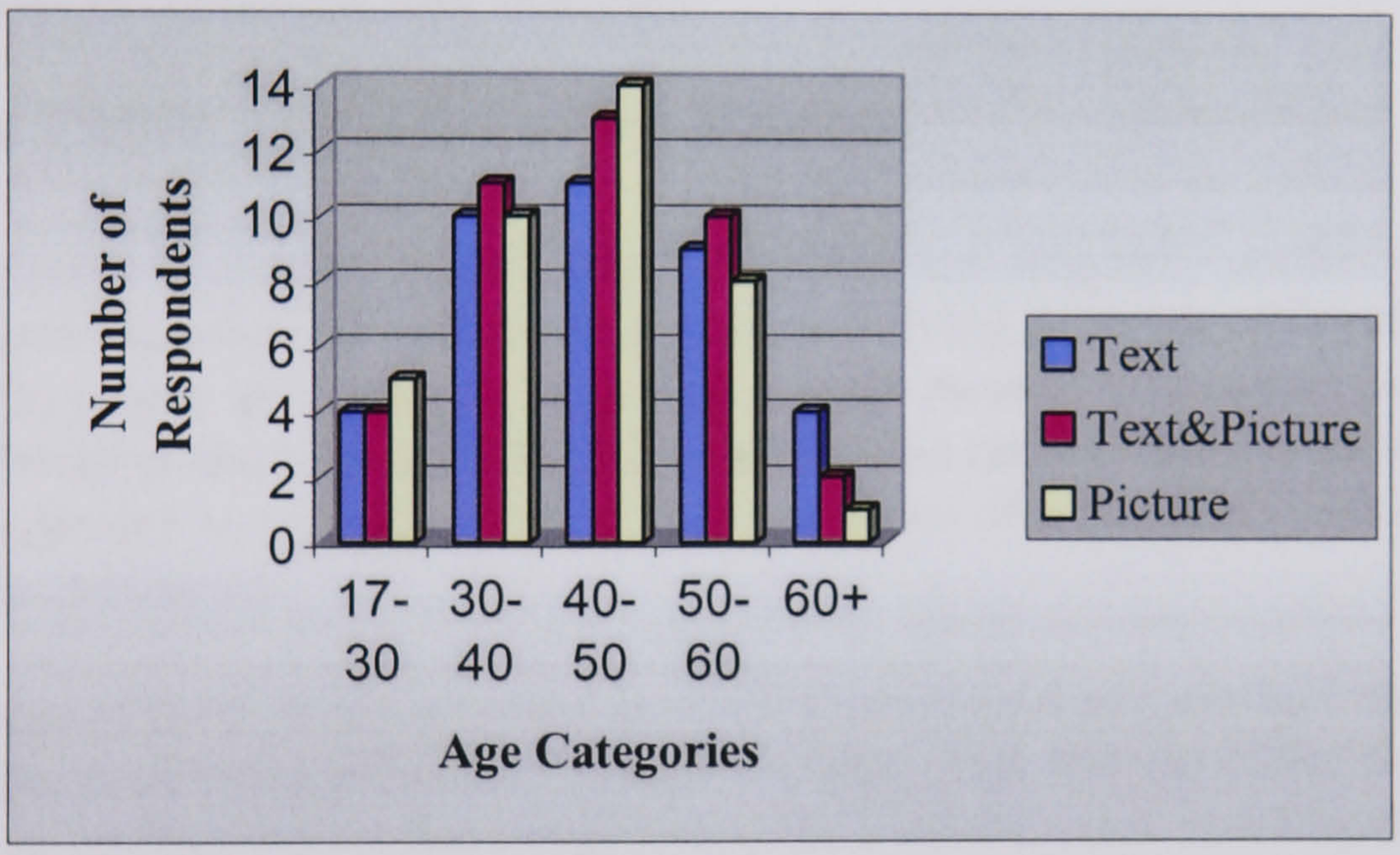


Figure 15: Distribution of Respondent Ages for 3 different Samples (Text, Text&Picture, and Picture)

Examination of the ratio between male and female respondents was also found to be consistent between sample groups. This was also consistent with the breakdown of the respondents for the sample used in the pre-stated preference experiment fieldwork.

Consistency between the basic age and sex data of the sample group means that no potential problems were identified in terms of cross sample comparisons. This demographic consistency suggests that variation between sample groups in their preferences should be limited, although cannot be entirely ruled out. The area of preference variation between the sample groups will be discussed further in the chapter in light of the research findings from the analysis of the think-aloud protocols.

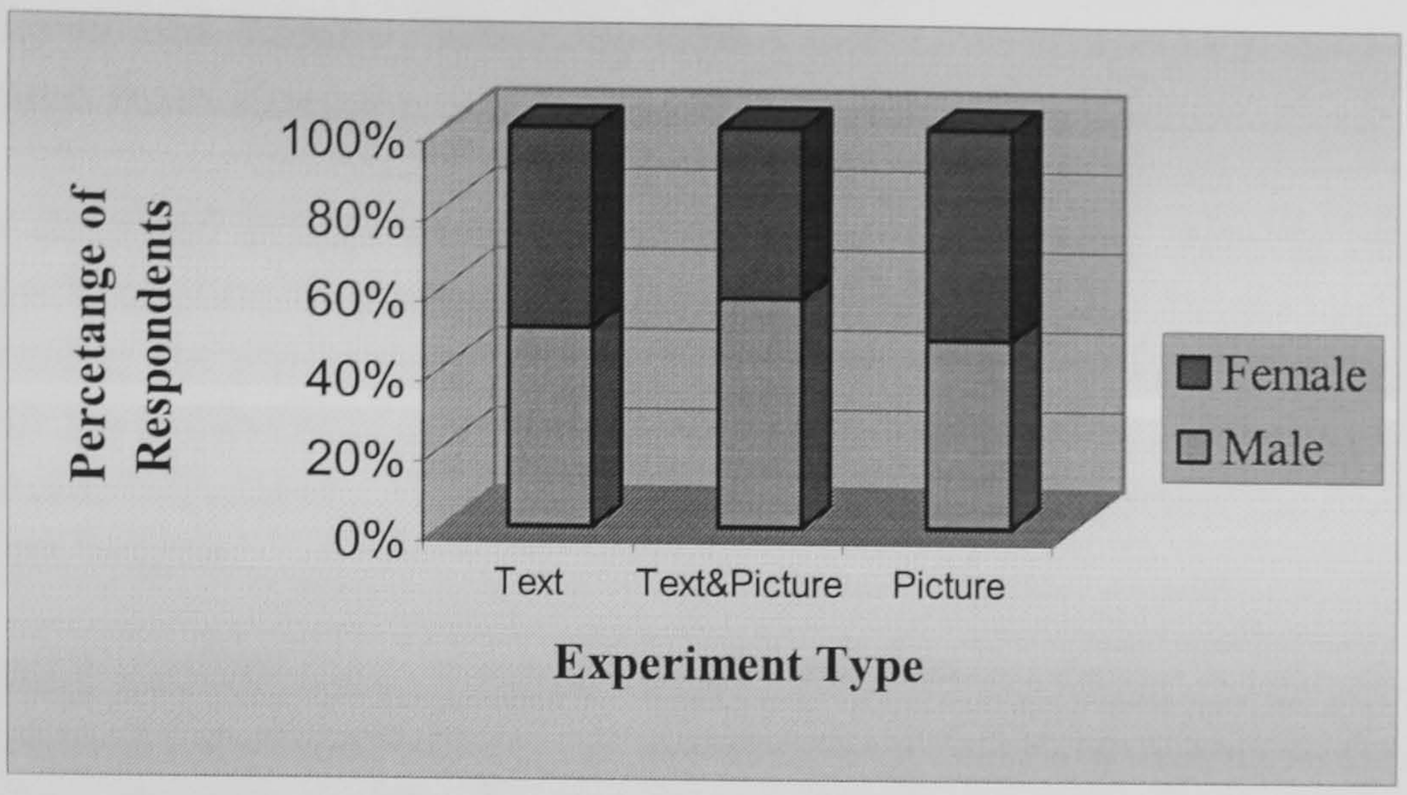


Figure 16: Respondent Gender for 3 Different Samples (Text, Text&Picture, and Picture)

The following sections describe the implementation of the think-aloud interview, and the analysis of the collected interview data.

6.3 The Think-Aloud Interview Process

As was discussed in chapter 3, think-aloud protocol was originally applied in the context of understanding an individual's problem solving processes (Newell and Simon, 1972) where *'the subject was verbalising the moment-to-moment contents of memory'* (Ericsson and Simon, 1980). It is within this context that the method is used within this research to understand the choice processes of individuals within stated preference experiments.

Whilst the use of think-aloud protocol is much championed as a method that allows the researcher to observe individual's cognitive processes, the use of the method is recognised as problematic in the elicitation of the data (Ericsson and Simon, 1980, 1993; Van Someren et al, 1994, Boren and Ramey, 2000). It is worth examining these criticisms and the suggested solutions, in order to describe how the think-aloud protocol implemented in this research aimed to identify respondent's use of information within the stated preference experiments.

Van Someren et al (1994) discuss the problem of some respondents who find it difficult to 'think aloud' whilst solving a problem. They also describe how some individuals find it difficult to talk and work at the same time, and so switch between the two actions. They suggest that whilst these subjects effectively use the think aloud method, long pauses imply that much of the thinking process is left unspoken. Ericsson and Simon (1993) however, suggest that the researcher can maximise the level of verbalisation by prompting the subjects to keep talking whenever there is a period of silence that is longer than expected. Rankin (1988) warns however that too much or too direct intervention on the researcher's part however, should be avoided. Boren and Ramey (2001) state that they have experienced some evidence that when respondents were presented with a stark prompt, *'many participants apologized to the test administrator before resuming thinking aloud'.*

For thinking aloud protocol to produce data that represents respondents' true thought processes, Boren and Ramey (2000) describe a series of rules for the interview process adapted from Ericsson and Simon (1980, 1994):

1. **Give detailed initial instructions for thinking aloud.** Among other things, researchers should distinguish between explanation and thinking aloud, encourage the participant to speak constantly "as if alone in the room" without regard for coherency, and inform the participant that reminders will be given if he or she falls silent. Participants should also practice thinking aloud before the test begins.
2. **Remind participants to think aloud.** Reminders should come after a predetermined period of silence and should be as short and non-directive as possible. Reminders should also not encourage a sense of personal contact or heighten awareness of the researcher's presence. A successful reminder should result in the immediate resumption of thinking aloud, without pause for reflection or retrospection. "Keep talking" is Ericsson and Simon's recommended reminder.
3. **Otherwise, do not intervene.** After a task begins, the only interaction should be the reminder to think aloud, as needed. Any other interactions-including "neutral" questions or comments-taint subsequent performance and verbalization by re-directing attention.

These rules for eliciting think aloud protocol from individuals, which support the guidelines set out by Ericsson and Simon were adopted for this research. The following description presents the interview process employed during the think aloud interviews employed during the stated preference experiments undertaken for this research.

As suggested in the first of Boren and Ramey's (2000) rules stated above, it was thought very important that the respondent understood the 'think-aloud' interview process. It was also considered important that the respondent was reassured that the stated preference experiment and the think-aloud protocol were not tests (that there were no right or wrong answers). The interview began therefore with the following introduction from the researcher:

> *'I am going to show you a series of choice cards, where a Volkswagen Golf is compared with a new car that Volkswagen have developed, and are considering putting on the market. The attributes of each car are described beneath a picture of each car. For each choice, I want you to look through the information, and choose which car you would prefer to buy and indicate on this scale of 1 to 5 (shows respondent response scale) You may also decided that you would not consider to buy either of the cars presented to you.*
>
> *I must stress that this is not a test, and there are no right or wrong answers to the choices. I am interested in what you think about the cars.*
> *Whilst you are examining the choices, and deciding which car you prefer, I would like to ask you to say everything you are thinking aloud – so you*

think aloud you thoughts. If you make a pause, I will remind you to keep talking aloud. Do you understand?'

These instructions aimed to elicit everything the respondent was thinking about the task of choosing the car they would most like to buy. It was not intended that the respondent should explain how or why they have used or ignored the different pieces of information presented to them, as this may have caused a change in the way in which they had used the information presented to them. This distinction between thinking-aloud their process of choosing a preferred car, and explaining their use of information presented to them, relates to the first of Boren and Ramsey's (2000) rules explained previously.

Once the respondent agreed that they understood the process, the stated preference experiment would begin. As suggested in the second of Boren and Ramey's (2000) rules described above, any pause in the respondents speech of more than a pre-determined period of silence (in this case, 5 seconds), a short reminder of 'keep talking' was stated by the interviewer. Hence the respondents were made to talk at all times during the interview, so that there was no opportunity for them to use information without the knowledge of the interviewer. Unlike the cases described by Van Someren et al (1994) and Ramey and Boren (2001) highlighted earlier, respondents in this research received this prompt well, and resumed thinking aloud immediately. Other than the use of this short prompt, no other intervention or questioning was made by the interviewer during the think aloud process.

As an example of the kind of output this interview process would produce, an extract from one of the interviews where text and pictures were used to represent the attribute 'vehicle appearance' is provided below. The extract is a respondent thinking aloud during the first choice card that was presented to them:

'Well with the Golf... its prettier than the other one. The new one doesn't look like the kind of car I would have normally. [Keep talking] *4 seat ..3 door petrol engine... steel, 3 doors...12 grand.... Oh but the other cars only 8 grand... that's good. Medium sized four seater, ... 3 doors so that's the same, its made of carbon but that doesn't bother me, petrol engine as well. Well... I'd have the 8 grand one. I will definitely go for number 5.'*

In this extract of the interview, the researcher was required to make one prompt to the respondent to 'keep talking'. The respondent immediately resumed thinking aloud. During the interview process, stated preference choice scenarios (described in chapter 5) were presented to the respondent in random order, until all 16 cards had been examined. The order that the choice scenarios were presented to the respondent was recorded. This was recorded so that during the analysis the researcher could determine whether a respondent's use of information was affected by the presentation of specific choice scenarios (with attributes at particular levels).

All the interviews were tape recorded, so that the exact think-aloud protocol could be transcribed accurately after the interview for use in the analysis.

The next section describes how the elicited think aloud data was analysed.

6.4 Analysing the Think-Aloud Data – The Four Stages

This section provides an overview of the analysis of the think-aloud data. This analysis is described in terms of 4 stages, depicted in figure 14, before more detailed discussion of the analysis is provided in later sections.

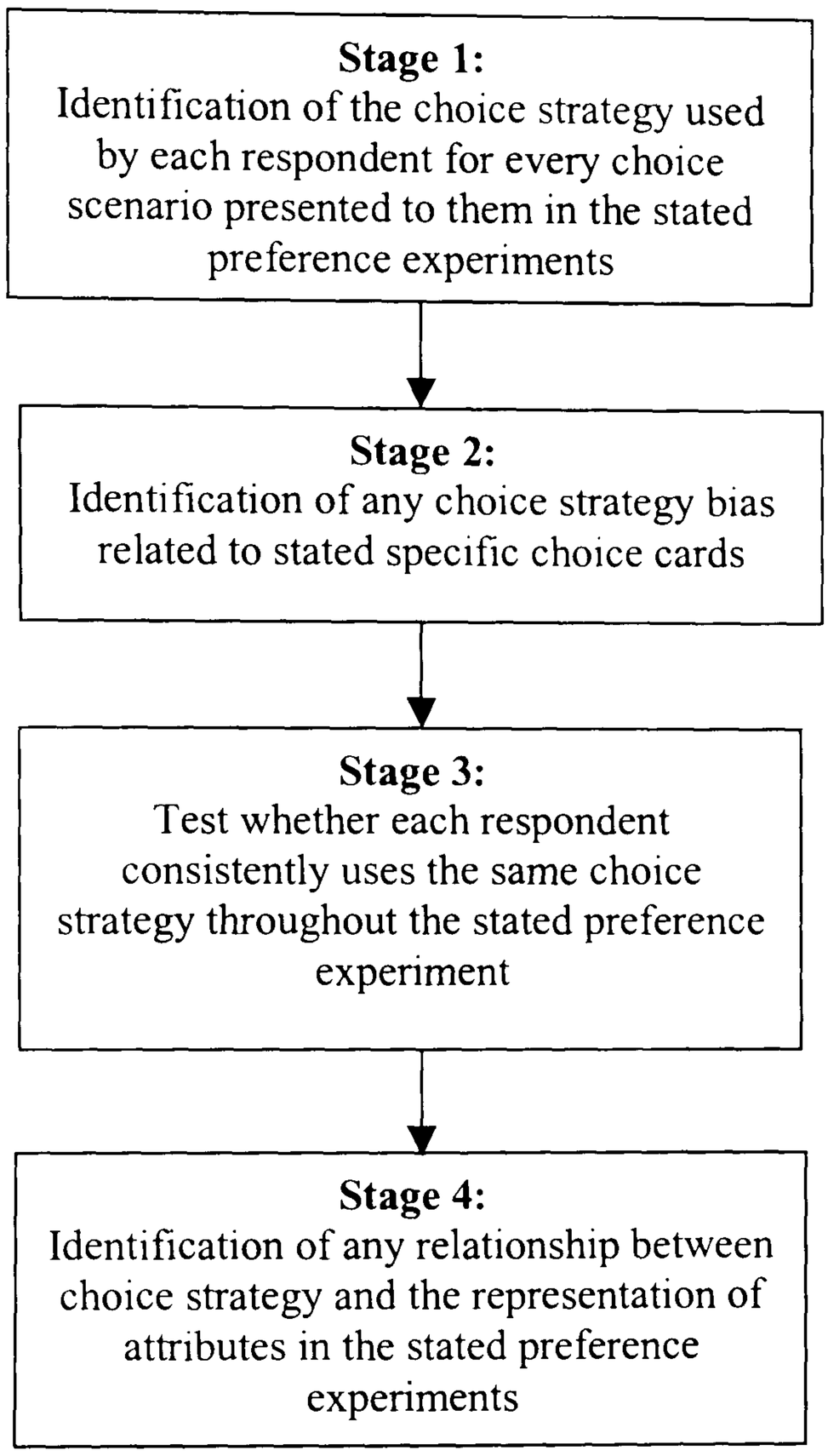


Figure 17: Overview of the 4 Stages of Analysis

In ***stage 1*** of the analysis, the choice strategy used by each of the respondents, to make every choice, for every choice scenario presented to them in the stated preference experiments is identified (*research question 1)*. In ***stage 2*** of the analysis, a possible link between the identified choice strategies, and specific choice cards, is examined in order to determine whether specific choice scenarios bias the choice strategy used by a respondent. In ***stage 3*** the choice strategies employed by respondents during the stated preference experiment are examined to whether respondents consistently used the same choice strategy throughout the stated preference experiment. ***Stage 4*** of the analysis examines the choice strategies used by respondents in the three alternative stated preference experiments, where the attribute 'vehicle appearance' is presented in three alternative ways: text; text&picture; or picture *(research question 2)*. The following sections discuss each of these four stages of analysis in more detail.

6.4 Identifying the Choice Strategies (Stage 1)

Chapter 5 described the design of the stated preference experiments used as the context for this research, 16 alternative choice scenarios were developed in the statistical design of the experiment. Chapter 5 also identified 3 sample groups, each including 40 respondents. These sample groups were presented three different stated preference experiments, where:

1. All attributes were represented using text.
2. The appearance of each of the vehicles was represented using photographs, whilst other attributes (fuel efficiency, price, engine type, fuel type, and body type) were represented using text.
3. The appearance of each of the vehicles was represented using photos, and also described in text. All other attributes were described using text.

The think aloud protocol used in this research therefore generated a total of 1920 choices (16 choices per experiment x 40 respondents per sample group x 3 sample groups).

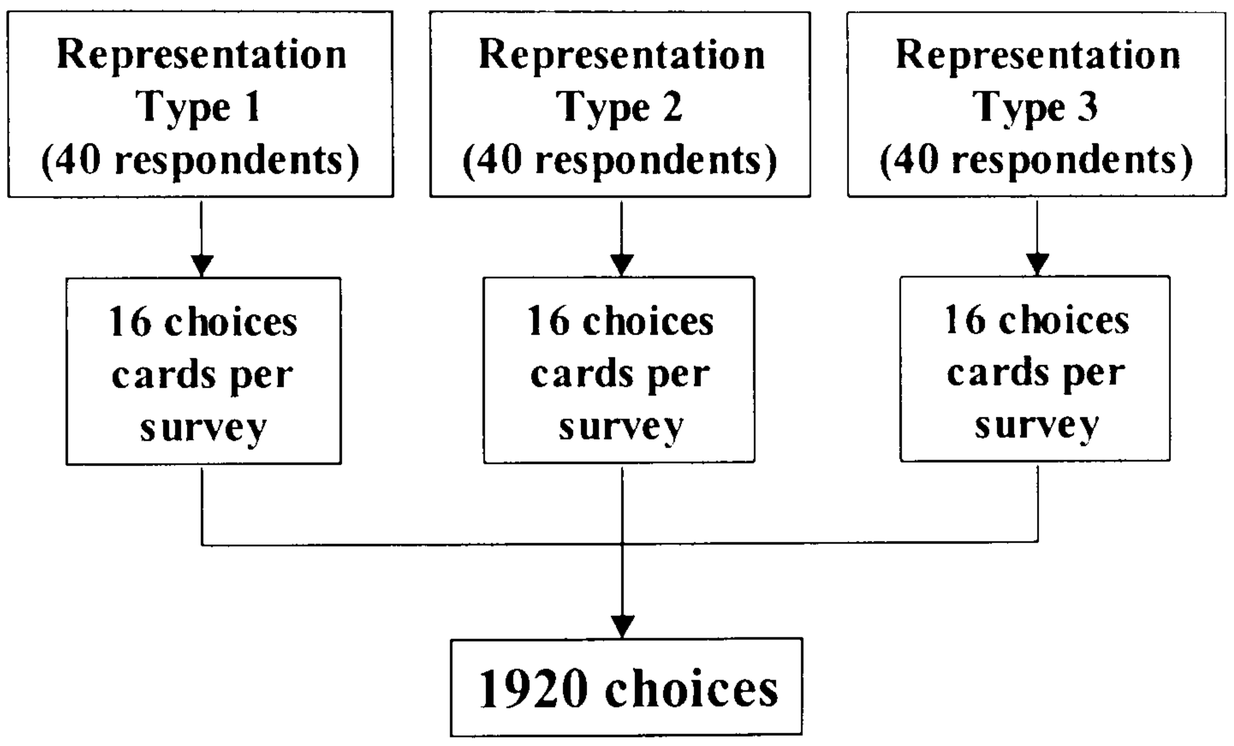


Figure 18: The number of choice scenarios analysed

The choice strategy employed by a respondent was described in chapter 2 (section 2.2.5) as a stage in the decision making process that relates to the way in which the respondent uses the information presented to him/her to state their preference in a choice scenario. In chapter 2 a number of possible choice strategies were also identified from the literature, which could be used by respondents during the experiment. These were:

- *Utility maximising choice strategies* are those usually assumed by stated preference practitioners. This means that respondents are believed to attach weightings to each/all of the attributes in a choice situation. It is assumed that the option with the highest total utility will therefore be chosen.

- *Dominance-based choice processes* are those where people select an option that is valued higher than all other alternatives on each attribute. For example, for the choice scenarios presented during the stated preference experiments

during this research, an individual would identify which vehicle was preferred, when valuing the choice based on only one of the attributes at a time. Which vehicle has the preferred appearance? Which vehicle has the preferred price? This would continue for all attributes presented within the choice scenario. This kind of choice strategy would clearly be likely not produce a single solution.

- *Maximax* and *maximin* choice strategies. People who use a maximin choice strategy identify the attribute that has the greatest negative impact upon the their total utility evaluation, and then choose the alternative that has the highest level of satisfaction (utility). People using a maximax strategy identify the attribute that has the greatest positive impact on a total utility evaluation and then chooses the option that provides the highest level of satisfaction (utility) from this attribute. This would not necessarily produce a single solution.

- *Lexicographic choice strategies* are those used when a person hierarchically orders all the attributes of choices they are about to make into the order that has the most influence upon their total utility evaluation, and then chooses the alternative with the highest value on the most important attribute. Here travel choices of this type are easy to find, for example the person for whom travel time is critical will choose the quickest journey over all other attributes.

- *Conjunctive choice strategies* are those made when a person rejects any alternative that fails to meet anyone of the minimum criterion of acceptability. This means that the individual sets an acceptable level for each attribute and rejects any alternative where the level/levels are not met. Conversely *disjunctive* choice strategies result in the acceptance of any alternative exceeding a certain criterion. Again this will not always give a single solution.

This first stage of the analysis therefore identifies, for each of the 1920 choices made by the total sample of 120 respondents, the choice strategy employed by the respondent, from this list of alternative choice strategies.

Whilst five different categories of choice strategies were identified within the literature as being used by individuals, only four types of choice strategies were identified from the analysis of the think aloud protocol used within this research. These four categories of choice strategies were: utility maximising, lexicographic, disjunctive choice strategies, and those choice strategies that were unidentified, yet non-utility maximising. The following sections describes how these categories were defined within this research, and provides examples of how these different choice strategies were identified, making use from the think-aloud interview transcripts.

A full breakdown of the choice strategies used by respondents, for each of the choices, for each of the three experiment types is then presented in tables 9, 10 and 11.

6.4.1 Identifying Utility Maximising Choice Strategies

Chapter 1 and 2 described how stated preference practitioners usually assume utility maximising choice strategies to be used by respondents, when undertaking the analysis of stated preference response data. In this type of choice strategy respondents are believed to attach weightings to each/all of the attributes in a choice situation. It is assumed that the option with the highest total utility will then be chosen.

Utility maximising choice strategies were identified as being used by respondents in some of the elicited think-aloud protocols. An example of a utility maximising choice can be seen from the following interview extract – which is a think-aloud protocol taken during the first choice presented to a respondent.

> *'Two cars... they look very different... the New one looks quite strange really... 4 seater hatchback... 4 seater hatchback so they are both the same type of car. There both made of steel...that pretty normal I suppose. Ah, the Golf's got 4 doors though...whereas the other car has only got 3 doors. ...but then the new car is only £8000 rather than £12000 that's much cheaper ...quite a lot cheaper ...4,0000 would make a big difference really ...oh and they are both petrol cars... but the new one costs a lot less to run - 65 mpg rather than 40 mpg - that's really good isn't it? I am buying a new car partly because I am moving to a job that which will mean a lot more driving – so having a car that is cheap to run would make a big difference...I am not sure I would pay 4000 more to have a car that's four doors, especially if the new one is cheaper to run... even if the new one does look a bit weird. No I think I would definitely choose the new car'.*

In this example, the respondent examines every attribute of both the vehicles. Those attributes that exhibit differences between the two cars on the choice card (in this example, price, fuel efficiency levels, and the number of doors, and the appearance of the vehicles) are carefully weighed up against each other before the respondent states a carefully considered preference between the two vehicles.

In the example described above, the respondent carefully considered all the attributes that describe the two vehicles. Weighing up all the attributes was part of the definition initially made for utility maximising choice behaviour. However many respondents followed what appeared to be a utility maximising choice strategy for all the attributes other than 'body type'. This was because respondents associate an insignificant level of utility with any *difference* in body type between the two vehicles being examines. This would therefore not affect their overall utility weighting.

The attribute 'body type' (with levels, carbon, aluminium, or steel) was included within the stated preference experiment design, because it was of interest to the ASCC designers to see how consumers value different materials used in the building of a vehicle. In fact the ability for market researchers to be able to include such 'secondary attributes' within a stated preference experiment has been highlighted as an advantage within the stated preference literature (for example see Pearmain et al. 1991). However discussion with respondents at the end of the stated preference experiment showed that body type was not influential in their decision to purchase a

particular type of car. This supports the pre-stated preference attribute elicitation research that was presented in chapter 4. In this earlier research, not one respondent stated that the material that the car body was made out of influenced their car buying decision. Therefore, if no utility is associated with any difference in this attribute between the two vehicles, it can be argued that a respondent is still employing a utility maximising choice strategy if this attribute is not considered within the choice process. The following definition of utility maximising choice behaviour was therefore used:

> *A respondent is believed to attach weightings to each/all of the attributes elicited as important in influencing a car buying decision within the pre-stated preference research presented in chapter 5 (those attributes that are believed to have an associated utility weighting that is not equal to 0). A respondent can therefore be assumed to be making a utility maximising choice, even if the car body type is not considered in this choice strategy.*

6.4.2 Identifying Lexicographic Choice Strategies

Lexicographic choice strategies were identified as being used within the think-aloud interview data elicited from stated preference experiment respondents. Lexicographic choice was defined in chapter 2 as those used when a person hierarchically orders all the attributes of choices they are about to make and then chooses the alternative with the highest value on the most important attribute. For example the person for whom price is critical might choose the cheapest car over all other attributes. If several attributes are considered of close importance, then attributes might also be grouped, into a hierarchy of grouped attributes. Understanding the definition of a lexicographic choice strategy is easier with an example.

In the third choice presented within the stated preference experiment, one respondent's think-aloud protocol was as follows:

> *'Hmm, the Golf has got 5 doors whereas the other one has only got 3. I have a 3 door car now and it annoys me when I am dumping stuff in the back seat. Between these two cars, I would definitely choose the Golf'*

In the choice described above the respondent clearly valued the number of doors a car had most highly. This respondent did not consider any of the other attributes presented on the choice card. Interestingly, in the following choice card presented to this respondent, both the vehicles had only 3 doors, and the respondent was forced to state her preference based on the valuation of another attribute.

> *'This time both cars have got only 3 doors. ...but the Golf is only £12,000 and the new car is £8,000 ... ...well I am not sure.. even though it is more expensive, I prefer the way the Golf looks. I suppose between these two cars I would probably buy the Golf.'*

On this occasion, the attribute that was most influential in the decision (the number of doors) was unable to provide a clear difference between the two vehicles on which the respondent could make their choice. The respondent therefore examined two further

attributes, appearance and price, on which to make a decision. Further probing of the respondent at the end of the experiment also confirmed the ranking of these attributes.

The type of choice strategy identified above, strictly adhered to the definition of lexicographic choice identified within the literature. However another type of choice strategy identified as being used by respondents in the think aloud interviews was considered to be a hybrid choice strategy – which combined both elements of lexicographic choice, and utility maximisation. In this type of choice strategy, respondents hierarchically order groupings of attributes that are considered to hold the same or similar level of utility, and then employ a utility maximising choice strategy to the highest value grouping of attributes. This type of choice strategy, when identified was grouped under the heading of lexicographic choice.

6.4.3 Identifying Conjunctive and Disjunctive Choice Strategies

Conjunctive choice strategies are those made when a person rejects any alternative that fails to meet anyone of the minimum criterion of acceptability. This means that the individual sets an acceptable level for each attribute and rejects any alternative where the level/levels are not met. Conversely *disjunctive* choice strategies result in the acceptance of any alternative exceeding a certain criterion. Again this will not always give a single solution.

Conjunctive choice strategies were identified within the think-aloud protocols elicited from new car buyers. An example of a conjunctive choice strategy employed by a respondent can be seen in the following extract from an interview, where the respondent is being presented with his first choice.

> *'Well the two cars are completely different aren't they? The new car looks far more modern than the Golf. A lot of the cars that are coming out now are weird looking. I suppose this one isn't too bad though. Oh hold on ... its £18,000...and the Golf's only £12,000. 18 is far more than I was planning on paying. Out of these I would have to choose the Golf, I couldn't afford to pay out that much. So I would definitely choose the Golf'.*

In the choice above a constraint on the respondent's budget meant that he had to reject the car priced at £18,000. None of the other attributes were weighed up against the price of the vehicles. The decision to choose the Golf was based purely on the rejection of the more expensive car.

6.4.4 Other Identified Choice Strategies and Problems with Identification

Whilst it was often possible to see that a respondent was using some kind of information screening (and therefore non-utility maximising) approach to make their decision, it was occasionally difficult to identify one specific strategy that was being employed.

In order to understand the difficulties surrounding the identification of the choice strategy used during the stated preference experiment for some respondents, it is useful to examine the following example:

> *'I prefer the look of the new car, it looks quite sporty... the other one looks a bit old lady-ish for me! Medium sized 4 seater hatchback.....medium sized 4 seater hatchback with rounded aerodynamic.....5 doors... And the new one has got 3 doors. Well for this choice I would choose the new. I think cars look much more sporty when they are the 3 door type .'*

The respondent in the above extract began by reading and comparing each attribute. She compared the appearance of the two cars, preferring the New (the ASCC). She also noted that both cars were 4 seater hatchbacks. On examining the number of doors, her examination of the available information stopped. The number of doors was very important to her, and so she chose the 3 door New over the 5 door Golf. Determining which choice strategy this respondent used, simply on this interview extract is problematic. Clearly she has deviated from the utility maximising strategy assumed by most stated preference practitioners, as she has not attached weightings to each of the attributes in a choice situation. This can clearly be seen by the way she ignored four of the attributes on the choice card (engine type, body type, price, and fuel-efficiency level).

It is possible from the evidence provided on the interview transcript that the respondent employed *a lexicographic choice strategy.* As stated earlier this type of strategy is used when a person hierarchically orders all the attributes of choices they are about to make and then choose the alternative with the highest value on the most important attribute. In this example, the respondent's highest attributes were the number of doors and the related attribute appearance. She therefore chose the choice with the highest number of doors (which she preferred). However, it is also possible that the respondent employed a *conjunctive choice strategy* for this choice. This type of strategy (as described above) is that made when a person rejects any alternative that fails to meet any one of the minimum criterions of acceptability. In this example, the respondent rejected the Golf because it only had 5 doors, and she preferred a car with 3 doors.

Clearly, identifying the exact choice strategy employed by a respondent was sometimes problematic during the analysis of the think-aloud interviews. However, it was possible in every case to determine whether or not the respondent had employed a utility maximising choice strategy or not. This therefore allowed the author to determine whether respondents were deviating from the assumptions used by stated preference practitioners.

6.4.5 Identified Choice Strategies

Given the problems with identification, not all choice strategies could be accurately identified. However these could be categorised as utility maximising and non-utility maximising choice strategies. The non-utility maximising choice strategies were further categorised into three types:

- Lexicographic choice strategies
- Conjunctive Choice Strategies
- Unidentified, but non-utility maximising choice strategies

No further choice strategies were identified from the think-aloud interview data. Of the choice strategies identified from literature, neither dominance based choice strategies nor maximax or maximin choice strategies, were identified as being used by respondents within the think aloud interviews. Respondents were asked to state their preference between two vehicles (and therefore highlight their preference for *one* vehicle). However, dominance based and maximax and maximin strategies cannot guarantee only one solution. It is likely therefore, that the type of task presented to the respondents (which required them to select only one preferred vehicle) caused respondents not to use these strategies.

The choice strategies that *were* identified as being used by the respondents during the think aloud interviews are presented in tables 9 to 11. Each table presents the choice strategies used, as a percentage of the total number of choices made for each choice scenario presented during the experiment, within each of the three samples (that represent the three different stated preference experiments). The choice scenario presentation number therefore refers to the order in which the scenarios were presented (i.e. choice scenario 1 refers to the first choice presented to each respondent, choice scenario 2 represent the second choice presented to respondents and so on).

Choice Scenario Presentation Number	% of Utility Maxising	% Lexicographic	% Conjunctive	% Other
1	87.5	2.5	10	0
2	85	12.5	2.5	0
3	72.5	27.5	0	0
4	22.5	77.5	0	0
5	10	85	5	0
6	0	82.5	12.5	5
7	0	95	5	0
8	0	92.5	5	2.5
9	0	95	5	0
10	0	92.5	7.5	0
11	0	92.5	5	2.5
12	0	97.5	2.5	0
13	0	92.5	7.5	0
14	0	95	2.5	2.5
15	0	92.5	7.5	0
16	0	90	5	5

Table 9: Choice Strategies Used by Respondents (Text Sample)

Table 9 presents the choice strategies identified as being used by respondents presented with the stated preference experiment that represented attributes using text only. In the first choice presented to respondents during the stated preference experiment, most respondents (87.5%) used a utility maximising choice strategy. However the use of utility maximising choice strategies can be seen to continually decline as the experiment progresses, and by the fourth choice scenario presented to respondents, most respondents were using non-utility maximising choice strategies (with only 22.5% using utility maximising choice strategies). From the sixth choice onwards, no respondent within this 'text only' sample was identified as using utility maximising choice strategies.

Choice Scenario Presentation Number	% of Utility Maxising	% Lexicographic	% Conjunctive	% Other
1	95	0	5	0
2	90	10	0	0
3	77.5	20	2.5	0
4	70	22.5	5	2.5
5	27.5	70	0	2.5
6	7.5	92.5	0	0
7	2.5	95	2.5	0
8	2.5	92.5	2.5	2.5
9	0	97.5	2.5	0
10	0	100	0	0
11	0	92.5	2.5	5
12	0	100	0	0
13	0	97.5	2.5	0
14	0	100	0	0
15	0	97.5	2.5	0
16	0	97.5	0	2.5

Table 10: Choice Strategies Used by Respondents (Text&Picture Sample)

Table 10 presents the choice strategies identified as being used by respondents presented with the stated preference experiment that represented the attribute 'vehicle appearance' using text and pictures, whilst representing all other attributes using just text. In the first choice presented to respondents during the stated preference experiment, most respondents (95%) used a utility maximising choice strategy (a higher level than the 87.5% in the text only sample). As in the 'text only' sample, the use of utility maximising choice strategies can be seen to continually decline as the experiment progresses. At one choice scenario later than in the 'text only' sample (at the fifth choice scenario presented to respondents), most respondents were using non-utility maximising choice strategies (with only 27.5% using utility maximising choice strategies). From the ninth choice scenario presented to respondents, no utility maximising choice strategies were identified as being used by the respondents within this sample.

Choice Scenario Presentation Order	% of Utility Maxising	% Lexicographic	% Conjunctive	% Other
1	97.5	0	2.5	0
2	92.5	5	2.5	0
3	85	15	0	0
4	82.5	17.5	0	0
5	55	40	2.5	2.5
6	30	67.5	0	2.5
7	5	95	0	0
8	0	97.5	2.5	0
9	0	95	2.5	2.5
10	0	97.5	2.5	0
11	2.5	97.5	0	0
12	0	100	0	0
13	0	97.5	2.5	0
14	0	100	0	0
15	0	97.5	0	2.5
16	0	97.5	2.5	0

Table 11: Choice strategies used by respondents (Picture Sample)

Table 11 presents the choice strategies identified as being used by respondents presented with the stated preference experiment that represented the attribute 'vehicle appearance' using only pictures, whilst representing all other attributes using just text. In the first choice presented to respondents during the stated preference experiment, most respondents (97.5%) used a utility maximising choice strategy (a higher level than the 87.5% in the text only sample or the 95% in the 'picture and text' sample). As in the other sample groups, the use of utility maximising choice strategies can be seen to continually decline as the experiment progresses – other than one utility maximising choice strategy (representing 2.5% of the choices in the sample) identified for the eleventh choice scenario presented to respondents. At one choice scenario later than in the 'picture and text' sample (at the sixth choice scenario presented to respondents), most respondents were using non-utility maximising choice strategies (with 30% using utility maximising choice strategies). From the eighth choice scenario presented to respondents, no utility maximising choice strategies were identified as being used by the respondents within this sample.

All three of the sample groups exhibited a high use of utility maximising choice strategies by respondents in the first choice scenarios presented in the stated preference experiments. However a declining use of this type of choice scenario was seen in all three samples, with an increasing use of lexicographic choice strategies in particular. This clearly deviates from the assumption commonly made by stated preference practitioners in the analysis of stated preference response data, that respondents employ utility maximising choice strategies to make their responses (as discussed in chapters1 and 2).

Sections 6.6 - 6.8 further examine the choice strategies identified and their relationship between: specific choice scenarios (and their associated attribute levels); the presentation order of choice scenarios; and the representation of attributes within the stated preference experiments.

6.5 Choice Strategy Bias Relating to Specific Choice Scenarios (Stage 2)

Each of the 16 choice scenarios presented to the respondents with the stated preference experiment, had attributes at varying levels and therefore represented a unique scenario. The attribute levels associated with these choice scenarios were presented in chapter 5, and are presented again here as table 12.

Scenario No.	Price of ASCC	Body Type of ASCC	Fuel efficiency of ASCC	No. of doors of comparison	Fuel type of ASCC
1	18000	Carbon	65	3	Diesel
2	18000	Carbon	40	5	Petrol
3	12000	Aluminium	40	3	Petrol
4	8000	Steel	40	3	Petrol
5	8000	Steel	65	3	Petrol
6	8000	Steel	65	5	Petrol
7	8000	Steel	40	5	Diesel
8	8000	Steel	120	3	Diesel
9	18000	Carbon	120	5	Petrol
10	18000	Carbon	40	3	Diesel
11	8000	Steel	40	5	Petrol
12	12000	Aluminium	40	5	Diesel
13	12000	Aluminium	120	3	Petrol
14	8000	Steel	40	3	Diesel
15	8000	Steel	120	5	Diesel
16	12000	Aluminium	60	5	Diesel

Table 12: Attribute Levels of the Choice Scenarios

In the stated preference experiments, choice scenarios from a full set of 16 were presented to the respondent in random order (choice cards were shuffled by the researcher).

A respondent's individual preferences towards the attributes, and the level of these attributes, included within the stated preference experiment were not examined before the experiment itself was carried out because it was felt that this might bias the respondent's use of information within the experiment. It was therefore deemed important to test whether certain attribute levels affected the choice strategy used by respondents, to ensure that the research questions could be addressed without other factors biasing the results.

The choice strategies employed by all the respondents for each of the specific choice cards/scenarios (figure 16) were examined to try and identify any relationship. Furthermore, the raw think-aloud interview data was examined to identify cases of possible choice strategy bias relating to specific choice cards.

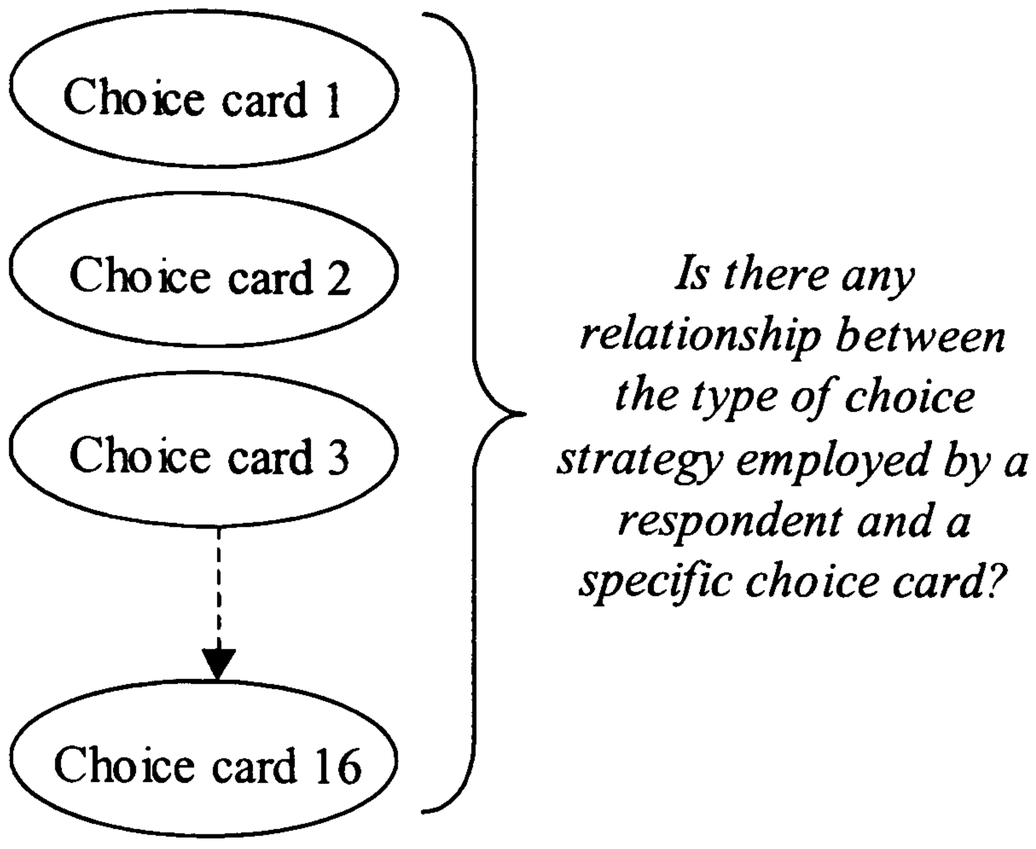


Figure 19: Identifying Choice Strategy Bias Relating to Specific Choice Cards

A cross tabulation of all the choice strategies identified for the full data set (all three samples) for each of the specific choice cards used within the experiment is presented in table 13. This shows a count of the number of times a particular choice strategy is identified as being used for each of the choice cards.

Choice Card Number	Choice Strategy Used By Respondent			
	Utility Maximising	Lexicographic	Conjunctive	Unidentified but non-utility maximising
1	28	88	2	2
2	29	86	5	0
3	26	87	7	0
4	31	85	2	2
5	30	88	1	1
6	28	88	3	1
7	29	89	1	1
8	27	85	7	1
9	28	88	2	2
10	27	87	6	0
11	28	89	2	1
12	29	87	2	2
13	28	86	6	0
14	27	90	3	0
15	28	86	5	1
16	30	88	1	1

Table 13: Counts of Respondents Choice Strategies for Each Choice Card Number

The way in which respondents make choices (the choice strategy used) for each specific choice scenario can be tested using the *chi-squared test for independence*. In this context the test examines whether the choice strategy employed by the respondent is independent of the specific card presented. This assumption of independence can be termed the null hypothesis. If independence between the two exists, the sample can be considered free of any bias relating to a specific choice card. If the choice

strategy employed and the choice cards presented are found to be dependent, then the alternative hypothesis can be accepted.

The null hypothesis of independence can be rejected at the 5% or 10% significance levels, but not at the 1% level. There is therefore, little evidence that an association exists between the variables. Detailed examination of the data found four respondents within the sample made use of conjunctive choice strategies for certain choice cards. All four of these respondents were found to have a constraint on their vehicle purchase – in that they required a 5-door vehicle. All vehicles with 3 doors were therefore automatically rejected, and this related directly to 6 specific choice cards.[6] These four respondents were removed from the sample, and the chi-squared tests were performed on the data again. With these four respondents removed from the sample, the null hypothesis was accepted at the 1%, 5%, and 10% confidence levels.

The revised samples, with these conjunctive choices removed, were therefore used for stages 3 and 4 of the analysis.

6.6 Choice Strategies and the Number of Choices Presented to the Respondent (Stage 3)

In section 6.4, that identified choice strategies used by the respondents for each of the choices made in the stated preference experiments, a declining use of utility maximising choice strategies by respondents was identified for those choices presented later in the experiment. Previous stated preference research (described in section 3.3.1) found that respondents undertaking experiments that used ranking exercises changed their choice strategies during the process of the experiment (Green and Srinivasan, 1978). No literature has been found that addresses whether respondents' choice strategies change during stated preference experiments that use choice exercises, as used in this research. This stage of the analysis of the think aloud data, therefore examines the possible relationship between the choice strategy used by the respondent and the presentation order of the choice scenarios within the *choice-based* stated preference experiments implemented within this research.

Figure 17 depicts the number of respondents using a utility maximising choice strategy for each of the choices presented to a respondent during a stated preference experiment. From this figure it can be seen that the number of respondents employing a utility maximising choice strategy reduces dramatically, the more choices are presented to the respondent during the experiment. By the choice 12, no respondents, from any of the three experiments implemented, are utility maximising the information available to them.

[6] One of these respondents was from the text only attribute sample, and two were from the text and picture attribute sample, and one was from the picture only attribute sample

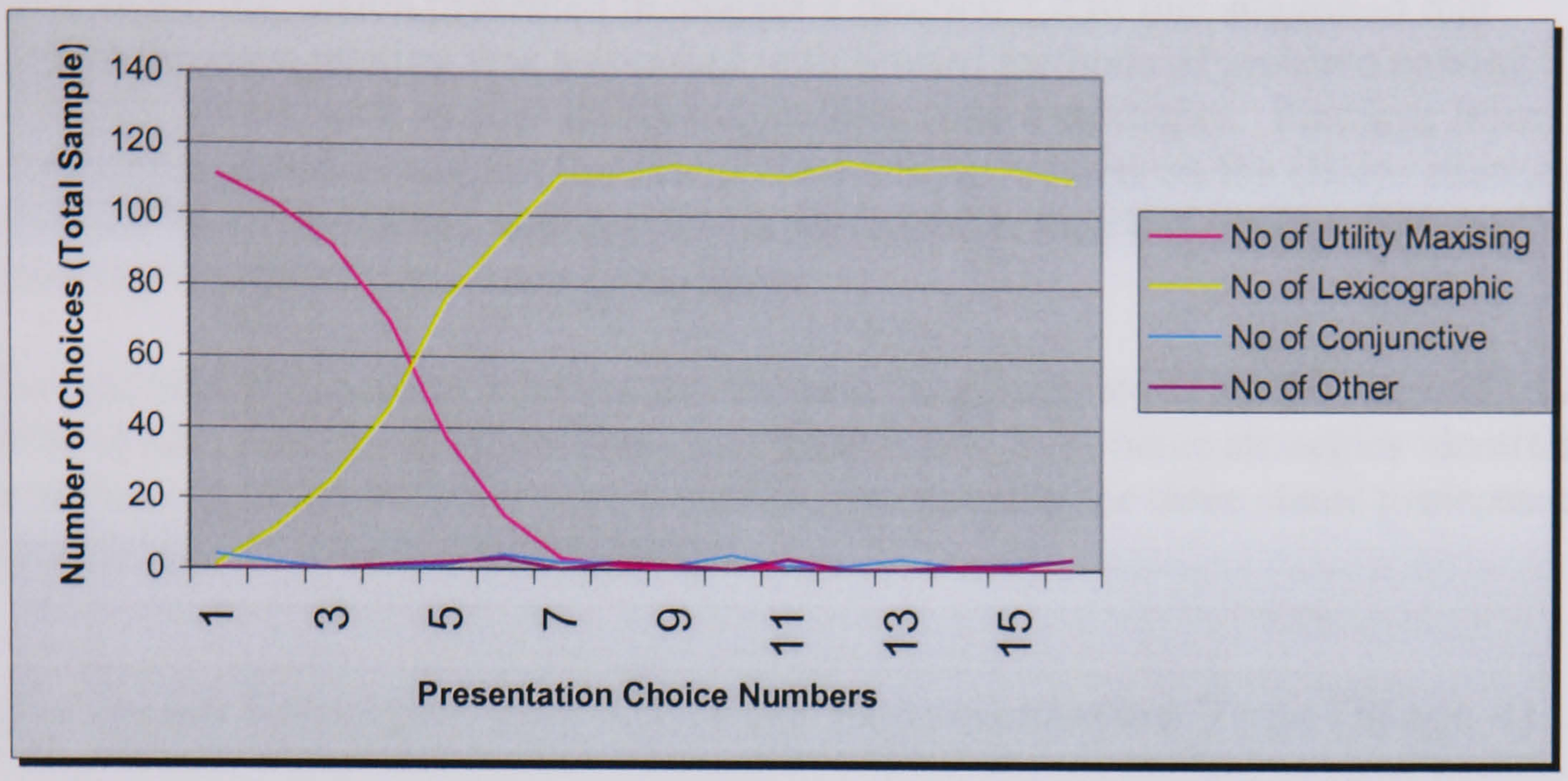


Figure 20: Choice Strategy and the Number of Cards Presented in the Experiment

To identify whether a significant association existed between the choice strategies used by respondents and the choice scenario presentation number, a series of Kolmogorov-Smirnov one-sample tests were undertaken. These tested the null hypothesis that there were no differences between the expected number of choices made by respondents using each of the different choice strategies, for each of the choice scenario presentation numbers. These tests were undertaken at a 1% confidence level. Table 18 presents the results from these tests for the full data set, and each of the three separate sample groups.

	Is there a significant association between the choice scenario presentation number and the use of the following choice strategies?			
SampleTested	**Utility Maximising**	**Lexicographic**	**Conjunctive**	**Unidentified but non-utility maximising**
Full Data Set	Yes	Yes	No	No
Text only	Yes	Yes	No	No
Picture&Text	Yes	Yes	No	No
Picture only	yes	Yes	No	No

Table 18: Results from the Kolmogorov-Smirnov One-Sample Tests

The results presented in table 18 suggest that there is significant association between the choice scenario presentation number and the use of utility maximising choice strategies and lexicographic choice strategies at the 1% confidence level.

Given that section 6.5 tested and identified no bias relating to the choice strategy used and the specific choice card numbers, and that the choice cards were shuffled into a random order for each respondent, it is useful to consider what might be causing the change is choice strategy employed by respondents as the stated preference experiment progresses. Chapter 5 (section 5.4.4) discussed guidelines presented by Kroes and Sheldon (1988) and Pearmain et al (1991) to limit the number of choices presented to a respondent to 16, because more than this could result in respondent

fatigue. The impact of respondent fatigue on an individual's choice process can be linked to the discussion presented in chapter 2 (section 2.2.6) that suggested that repeated decision making was associated with limited methods of problem solving (Solomon, 2000), such as non- utility maximising choice strategies. Findings from this research therefore suggest that respondent fatigue impacts on the choice strategy employed by a respondent, and this occurs much earlier than had previously been considered by stated preference researchers.

The next section considers whether the choice strategy employed by the respondent is related to the way in which attributes are represented. The choice strategies identified for each of the three different sample groups, representing the three stated preference experiments, are analysed and compared.

6.7 Choice Strategies and Attribute Representation Type (Stage 4)

Stage 4 of the analysis presented in this chapter aims to test whether the choice strategies used by respondents in these different sample groups were significantly different. In section 6.5, differences were identified in the number of respondents using utility maximising choice strategies used for each of the choice scenarios presented during the experiment, for each of the three sample groups. The three sample groups represented the respondents presented with three different stated preference experiments, where the attribute 'vehicle appearance' was represented using: 'text only'; 'text&picture'; and 'picture only'. The difference in use of utility maximising choice strategies between the three sample groups can be seen more clearly in figure 19 which shows the percentage of utility maximising choice strategies used by respondents for each of the choices in the three sample groups.

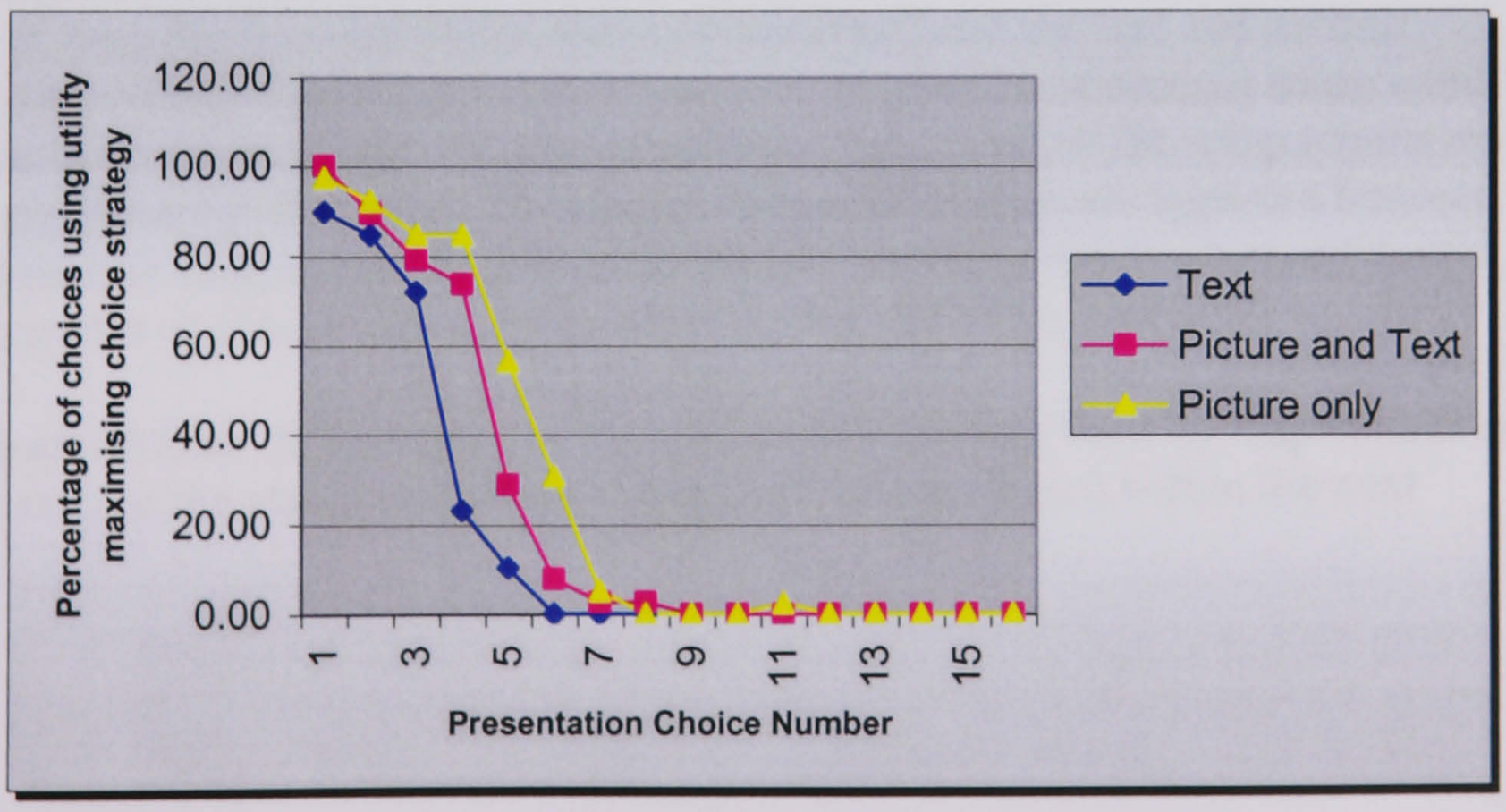


Figure 21: The Percentage of Choices Using Utility Maximising Choice Strategies

As can be seen in figure 19 and was previously discussed in sections 6.5, all three sample-groups exhibit a downward trend in the use of utility maximising choice strategies. However, differences exist between the percentage of respondents using

utility maximising choice strategies within each of the sample groups, for the first – eighth choice scenarios presented during the stated preference experiments.

To determine whether any statistically significant difference existed between the choice strategies employed for each presentation choice strategy, a series of hypothesis tests were carried out. These tested the hypothesis that there was no significant difference between the proportion of choices that use utility maximising choice strategies for each choice, for each presentation choice number for each of the stated preference experiment types used. Table 14 presents the resulting z statistics for each of the tests, and whether it is significant at the 5% level of significance.

Presentation Choice Number	Text and Picture& Text	Significant at 5% level?	Text and Picture	Significant at 5% level?	Picture& Text and Picture	Significant at 5% level?
1	-2.0533	yes	-1.3728212	no	1.006388	no
2	-0.6389	no	-1.0543112	no	-0.431701	no
3	-0.7331	no	-1.3604819	no	-0.643701	no
4	-4.4719	yes	-5.4123965	yes	-1.179023	no
5	-2.0791	yes	-4.3050688	yes	-2.437227	yes
6	-1.7904	yes	-3.7614372	yes	-2.548688	yes
7	-1.0198	no	-1.432456	no	-0.568313	no
8	-1.0198	no				

Table 14: Testing the Difference Between the Proportion of Utility Maximising Choices

In table 14 only choice numbers 1 to 8 (for the text and picture&text comparison) are and 1 to 7 (for the text and picture, and picture&text and picture comparisons) are compared. These were the only comparisons where at least one of the proportions being compared was different to 0. From the tests, significant (at the 5% level) differences can be seen for some of the presentation choice numbers. At choice number 4, both the text and picture&text comparison, and the text and picture comparison exhibit significant differences in the proportion of choices using a utility maximising choice strategy. At choice number 5 and 6, all of the comparisons made exhibit significant differences. Particularly large differences are apparent between the text and picture sample groups, where the picture sample group has a significantly higher number of choices using utility maximising choice strategies.

The impact of these differences found in the choice strategy used by respondents on the accuracy of the stated preference design will be considered within the next chapter.

6.8 Conclusions

This chapter described the implementation of a think-aloud protocol during three stated preference experiments. Analysis of the think-aloud protocol allowed the identification of the choice processes used by respondents during the three stated preference experiments (*research question 1)*. A number of different types of choice strategy were successfully identified within the research:

- Utility maximising
- Lexicographic choice strategies
- Conjunctive choice Strategies
- Unidentified, but non-utility maximising choice strategies

In all three of the stated preference experiments implemented, a high level of non-utility maximising choice strategies were identified as being used by the respondents. Furthermore a significant association was also identified between the choice scenario presentation number and the use of utility maximising choice strategies and lexicographic choice strategies. This association showed a declining use of utility maximising choice strategies by respondents as the stated preference experiment progressed. The possible effect of respondent fatigue on the individual being presented with repeated choice cards was highlighted as the underlying reason for this change in the choice strategy used by respondents during the experiment.

The chapter also identified significant differences between the choice strategies used by respondents during the stated preference experiments when the attributes were represented in different ways *(research question 2)*. Particularly large differences were shown between the choice strategies identified between the experiment that used only text to describe the attributes, and those that included pictures. Those experiments including pictures exhibited a significantly higher number of choices using utility maximising choice strategies.

The following two chapters consider the implications of these identified non-utility maximising choice strategies on the estimation of consumer utility models and the associated utility estimates *(research question 3)*.

CHAPTER 7: ANALYSIS OF STATED PREFERENCE RESPONSE DATA

CHAPTER 2:
Theoretical Background to the Research Area

CHAPTER 3:
Research Methodology and Design

CHAPTER 4:
Determining of Stated Preference Experiment Attributes

CHAPTER 5:
Design of the Stated Preference Fieldwork

CHAPTER 6:
The 'Think-Aloud' Interview

CHAPTER 7:
Analysis of Response Data

- *Estimation of Consumer Utility Models*
- *Identifying Differences in the Model Parameters and Between Sample Groups (Differing Experiment Representations)*

CHAPTER 8:
Examining the Impact Differing Choice Processes on Estimated Utility Models

CHAPTER 9:
Conclusions

7.1 Introduction

Chapter 6 identified the choice processes used by respondents during the three stated preference experiments (*research question 1)*. The chapter also identified significant differences between the choice strategies used by respondents during the stated preference experiments when the attributes were represented in different ways *(research question 2)*. This chapter analyses the response data collected during the stated preference experiments and estimates consumer utility models. The estimated models are compared in order to assess the impact of the different identified choice strategy profiles used by respondents in each of the three experiments *(research question 3)*. The term *choice strategy profile* is used within this thesis to mean the set of choice strategies used by respondents within each of the three sample groups (that were presented with the three alternative stated preference experiments – text, text&picture, and picture).

Section 7.2 begins by describing the analysis of the response data collected within the three stated preference experiments. This analysis includes an explanation of how the identified non-utility maximising choice strategies were represented within the estimation process. Section 7.3 of this chapter then compares the models estimated from the sets of response data from each of the three stated preference experiments. If the choice strategy employed by respondents during the stated preference experiments does impact on the estimation of utility models, differences between the model parameters estimated from each of the three sample groups of response data would be expected. Further examination of the impact of differing choice strategy profiles on the model estimation is also examined through the analysis of the total data set (all three sets of response data). An estimated utility model for the full data set is compared with an alternative model, which includes dummy variables representing the three alternative choice strategy profiles associated with each of the three stated preference experiments. Significant improvement in the estimated model would be expected with the inclusion of the dummy variables representing choice strategy profile, if a relationship did exist between choice strategy used by respondents and the estimated model parameters.

The analysis of the stated preference response data, and subsequent examination of the estimated utility models is useful in providing an indicator of the possible existence of a relationship between the choice strategy used by respondents and estimated utility model parameters. However the choice of a research design that uses three different sets of respondents for each of the three stated preference experiments (justification of which is provided in chapter 3), means that identified differences between the responses (and models estimated from them) made from respondents in each of the sample groups, might be caused by differences between the preferences held by respondents in each of the sample groups, or by the way that the attributes were comprehended within each of the stated preference experiments. This is discussed further at the end of this chapter, which provides justification for further examination of the impact of choice strategies on utility model estimation in chapter 8, using simulated response data.

7.2 Estimation of Consumer Utility Model

7.2.1 Implementation of the Stated Preference Experiments

Chapter 5 described the design and implementation of the three alternative stated preference experiments used in this research. Figure 20 below, shows an example of a choice card presented to a respondent during the stated preference experiment that made use of pictures and text to represent attributes.

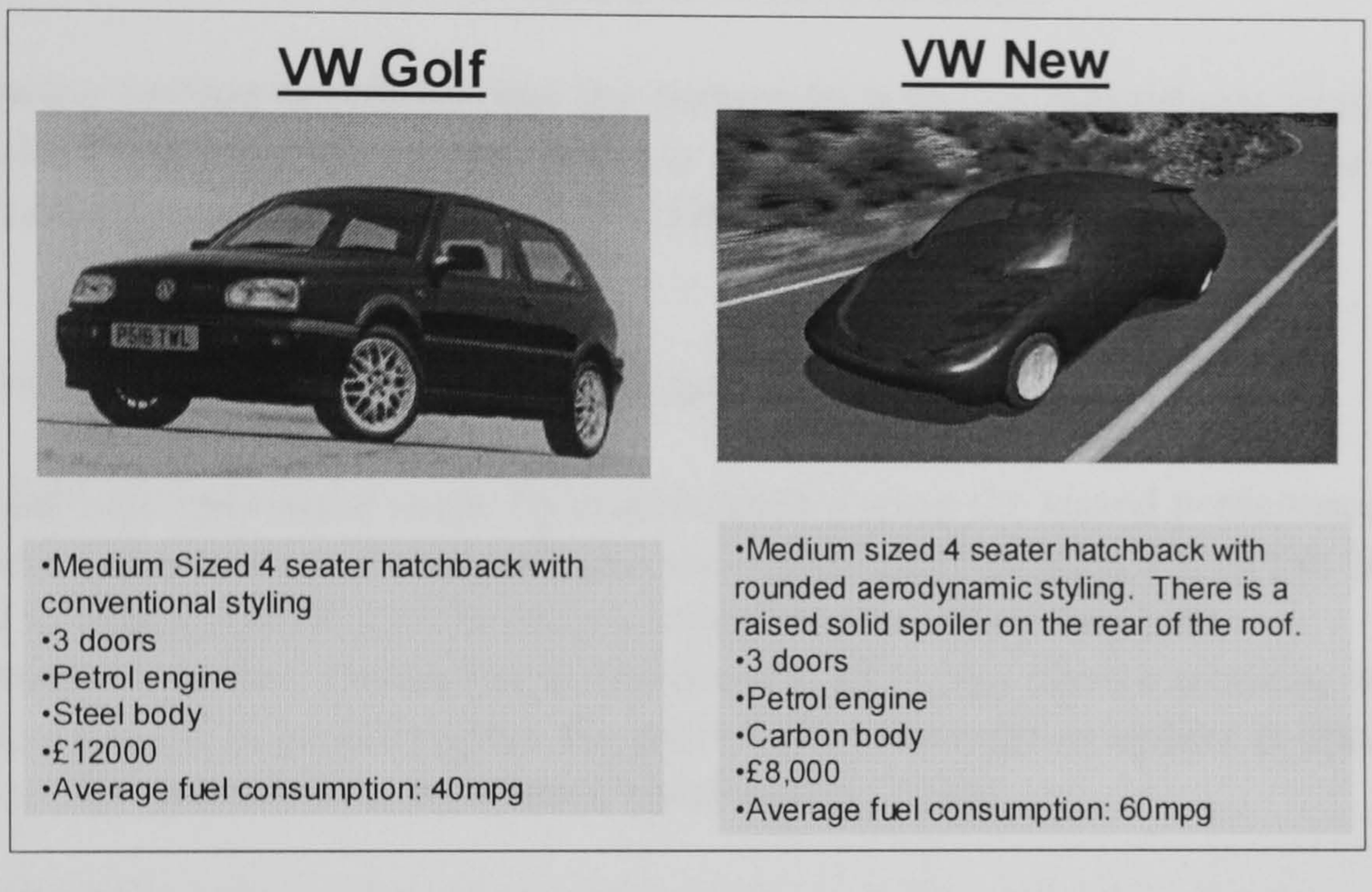


Figure 22: Example of an Stated Preference Choice Card

As depicted above, and described in chapter 5, respondents were presented with a choice between two vehicles, both described as Volkswagens. Each of the vehicles were described in terms of their respective vehicle attributes.

Each respondent was presented with 16 choice cards, in random order, and asked to make their response. Chapter 5 described how respondents were asked during the experiment to state their preferences to the different options on a five-point scale of probabilities. These five points on the scale had related verbal descriptions that were presented to the respondent as follows:

- Definitely choose the VW Golf
- Probably choose the VW Golf
- No preference between VW Golf and VW New
- Probably choose VW New
- Definitely choose VW New

These verbal descriptions are symmetrical around the central description *'no difference between VW Golf and VW New'*. Within stated preference practice, it has *'become almost standard practice'* for these verbal descriptions to be associated with a corresponding numerical scale of: 0.1, 0.3, 0.5, and 0.9 (Ortuzar, 2000). This scale allows relative comparisons between responses to be made (Pearmain et al., 1991).

This numerical scale was adopted for this research, and responses made by individuals within the stated preference experiments recorded in accordance to this scale. These probability values assigned to the verbal responses made by individuals are presented in table 15.

Definitely Choose the VW Golf	Probably choose the VW Golf	No preference	Probably Choose the VW New	Definitely choose the VW New
0.1	0.3	0.5	0.7	0.9

Table 15: Scaling of Choice Probabilies

The following section describes how the responses made by individuals against the above probability scale were translated into utility values, using the Berkson-Theil transformation (Bates and Roberts, 1986; Ortuzar, 2000).

7.2.2 Translating Choice Probabilities into Utility Values

The probabilistic responses made by respondents during the stated preference experiments (recorded on the probability scale presented as table 15, to the 16 choices presented to them, can be used to infer a respondent's utility function.
These models were first introduced in the context of binary choice models, where the logistic distribution is used to relate the probability that a given option is chosen to the expected utility gained from the choice (McFadden, 1978).

Swanson (1998) highlights the popularity of the model by stated preference practitioners, and Louviere et al. (2000) describe the *'convincing reasons'* for its common usage:

- Its simplicity in estimation;
- The speed to delivering 'good' or acceptable models on the accepted tests of model performance (i.e. overall goodness of fit, t-statistics for the parameters of each attribute, and correct signs of parameters);
- Accessible and easy to use packaged estimation software.

It is for these reasons, and its widespread usage amongst stated preference researchers, that the logit model was used to transform the probabilistic response of individuals into utility values in the analysis described within this chapter.

The logit model states that the probability of an individual choosing a scenario is related to the utility of that scenario as follows (Swanson, 1998; Bates and Roberts, 1986; MVA et al., 1987; Louviere et al., 2000):

Equation 1

$$P_T = \frac{1}{(1 + \exp(U_T)}$$

Where P_T = Probability of choosing a particular option
U_T = Utility associated with choosing a particular option

By transposing this relationship it is possible to write the probability in terms of utility:

Equation 2

$$U_T = \ln\{P_T /(1 - P_T)\ \}$$

The following section clearly describes how the non-utility maximising choice strategies used by respondents within the stated preference experiments, and identified in chapter 6, were represented within the analysis of these derived utility values.

7.2.3 The Functional Form of the Adopted Utility Function

The most commonly adopted formulation for the estimation of a utility function from stated preference data is that of a linear additive function (Louviere et al., 2000; Pearmain et al., 1991; Swanson, 1998; Ampt et al., 1995; 2000). Such a function would take the form of equation 3.

Equation 3

$$U_i = a_o + a_i X_i + ... + a_n X_n + e_i$$

where U_i = utility of option i
$X_i \ldots X_n$ = values of attributes
$a_0 \ldots a_n$ = model parameters
e_i = random disturbance term

In this function, the value of the attributes within a specific choice scenario, are represented by the X values. Each of these attribute values are weighted with regard to the influence they are determined to influence over total utility. These weightings, or part-worths as they are commonly called are represented by the variable parameters shown in equation 3 as $a_0 \ldots a_n$. A random term 'e' is also included within the function that takes into account random disturbances in the data that cannot be determined by the explanatory variables of the model. This random disturbance term might for example represent differences between the preferences of the sample respondents, or specific budget or other constraints.

Given the utility functions being estimated from the stated preference exercises in this research are described in terms the differences in utility, and difference in attributes between the two vehicles being presented, the associated utility function (based on the form shown in equation 3) would take the following form:

Equation 4

$$U_{A-B} = a_0 + a_1(X_{1A} - X_{1b}) + a_2(X_{2a} - X_{2b}) \ldots + b_n(X_{nA} - X_{nB}) + e$$

where U_i = utility of option i
$X_{1A} \ldots X_{nA}$ = values of the attributes of the VW New
$X_{1B} \ldots X_{nB}$ = values of the attributes of the VW Golf
$a_0 \ldots a_n$ = model parameters
e = random disturbance term

These compensatory utility functions shown as equation 3 and equation 4 are the most commonly assumed form of utility function estimated from stated preference choice data (Swanson, 1998). Refinement of this utility function to allow representation of the use of information by respondents within non-utility maximising choice strategies is discussed in the following section.

7.2.4 Representing Non-Utility Maximising Choice Strategies in the Analysis of the Stated Preference Response Data

Whilst the function presented as equation 4 is commonly adopted within stated preference research, it assumes (as discussed in chapters 1 and 2) that a respondent is using utility maximising (or compensatory) choice strategies to make their choice/response. A respondent's use of a utility maximising choice strategy within the context of the stated preference experiment within this research, would suggest that all the differences between the vehicle attributes presented in the choice scenarios is considered, and traded-off against each other in the process of determining their probability to purchase a particular car. As such, analysis of the data, when using this assumed model, tries to explain the variance in responses through the variance of all the attributes included within the model as variables. Chapter 6 however, which examined the think-aloud protocols of the respondents within the stated preference experiments, identified significant use of non-utility maximising choice strategies.

Green and Srinvasan (1978) provide a rare discussion of the implications of the existence of non-utility maximising choice strategies, although this discussion centres on the analysis of response data from ranking exercises (described in section 6.6). Green and Srinivasan suggest that whilst they found lexicographic and conjunctive choice strategies were commonly used by respondents they suggest that:

> *'for predictive validity this problem is not as serious at it initially seems. This is because the compensatory model of conjoint analysis can approximate the outcomes of other kinds of decision rules quite closely'.*

Further discussion of how to analyse lexicographic response data, whilst adopting a compensatory utility function is provided by Parker et al (1976). Lexicographic choices have been described previously (section 2.2.5) as those used when a person hierarchically orders all the attributes or choices they are about to make and then chooses the alternative with the highest value on the most important attribute. The publication by Parker et al (1976) provides the only discussion of practical methods

for analysing lexicographic data, and this method is adopted within this research. In this method of analysing the stated preference data, only those differences between attributes presented in the choice scenario that were identified as being used by the respondent were related to the simulated response for each choice. This analysis of this data can be explained more clearly if presented algebraically:

Equation 5:

$$U_{A-B} = a_0 + a_1 C_1 (X_{1A} - X_{1b}) + a_2 C_2 (X_{2a} - X_{2b}) \ldots + a_n C_n (X_{nA} - X_{nB}) + e$$

where U_{A-B} = difference in utility between the VW Golf and the VW New
$X_{1A} \ldots X_{nA}$ = values of the attributes of the VW New
$X_{1B} \ldots X_{nB}$ = values of the attributes of the VW Golf
$C_1 \ldots C_n$ = dummy variable representing the use of information within the choice scenario
$a_0 \ldots a_n$ = model parameters
e = random disturbance term

During the implementation of the think-aloud protocol (described in chapter 6), the described vehicle attributes that were *used within the choice strategy* by a respondent were identified and recorded. The use of this attribute information by respondents (i.e. whether the information was used or not used) is represented within the above utility function (equation 5) by variables C_1 to C_n. Variables of this sort, which do not represent continuous data, are usually referred to as 'dummy variables'. Draper and Smith (1998) suggest that *'in general, the most useful dummy variable set-ups are simple in form, employing levels of 0 and 1, for example'*. For the estimations presented within this chapter the dummy variables employ the levels 0, and 1. The dummy variables therefore take the following values:

$C_n = 0$ where the difference between attribute *n* of the two vehicles *is not* used within the respondent's choice strategy
$C_n = 1$ where the difference between attribute *n* of the two vehicles *is* included within the respondent's choice strategy

7.2.5 Defining the Model Variables Representing the Stated Preference Attributes

This section describes the representation of the attributes within the stated preference experiments as variables within the estimation of a utility model. Table 16 below, presents the attributes included within the experiment, and the relative attribute level used within the experiments.

Attribute	VW Golf	VW New
Appearance	Constant	Constant
Price	£12,000	£8,000, £12,000, £18,000
Number of doors	3 or 5	3
Body Type	Steel	Steel or Carbon or Aluminium
Fuel Efficiency	40 mpg	40mh or 60mpg or 80mpg
Fuel Type	Petrol	Petrol or Diesel

Table 16: Attributes and their Levels

Section 5 presented the utility function adopted for this research, which presents the variables within the model as differences in the attributes presented within the experiment. The difference in price, and the difference in fuel efficiency between the two vehicles presented in each of the stated preference choice scenarios are described in terms of continuous data. These differences can therefore be represented as actual values. However, the number of doors on the vehicles, body type, and fuel type do not represent attributes that are described by continuous data, each exhibiting two or three distinct/discrete levels. These attributes are therefore represented within the estimated utility function as 'dummy variables'. As previously described in section 7.2.4, the dummy variables used within this research employ the levels 0, and 1.

The variables types, number of doors and fuel type, were represented in the analysis by dummy variables that took the following form:

$X_1 = 0$ for both vehicles to have 3 doors
$X_1 = 1$ for the VW Golf to have 5 doors and the ASCC to have 3 doors
$X_2 = 0$ for both vehicles to have petrol engines
$X_2 = 1$ for the ASCC (VW New) to have a diesel engine, the VW Golf - petrol

To represent body type of the ASCC within the choice experiment, which has three possible levels (Carbon body, aluminium body, and no difference between the ASCC and the comparison vehicle), two dummy variables were employed:

(X_3, X_4) = (1, 0) for ASCC (VW New) to have a carbon body
= (0, 1) for ASCC (VW New) to have an aluminium body
= (0, 0) for no difference in body type of the two vehicles (both steel)

where X_1 to X_4 are the dummy variables.

7.2.6 Model Estimation

The response data was analysed to allow utility models to be estimated using least squared regression. This analytical method is commonly used in the analysis of stated preference data to produce part-utilities for the different attributes identified within the stated preference experiment (Pearmain et al., 1991, Louviere et al, 2000). A regression model produces *'part-utilities that minimise the sum of the (squared) differences between the predicted preference ratings and the rating provided by respondents'* (Pearmain et al, 1991).

Three utility models were estimated representing:

- The data set collected from the 'text only' stated preference experiment;
- The data set collected from the 'text&picture' stated preference experiment
- The data set collected from the 'picture only' stated preference experiment

The utility models were estimated using regression analysis, and adopted the functional form of the utility function already discussed in section 4. The three estimated models are presented in tables 17 to 19 and are described in terms of:

- The estimated parameter values
- The coefficient of determination (R^2)
- Significant values of t for the attribute parameters

Table 17 presents the model parameters and supporting regression output estimated from the response data collected using the stated preference experiment that presented attributes using text only.

Text Only Set			
$R^2 = 0.47$			
Attribute	**Parameter**	**T**	**T Signif. @ P=0.05?**
Intercept	-0.811	-12.2	Yes
Difference in Price	-0.262	-16.3	Yes
Difference in Body Type	0.314	1.61	No
Difference in Body Type	-0.266	-1.49	No
Difference in Fuel Efficiency	0.017	11.8	Yes
Difference in No of doors	-0.049	-0.622	No
Difference in Fuel Type	-0.030	0.308	No

Table 17: Text Only Experiment

Table 18 presents the model parameters and supporting regression output estimated from the response data collected using the stated preference experiment that presented the attribute 'vehicle appearance' using text and pictures, and all other attributes using text.

Text&Picture Set			
$R^2 = 0.53$			
Attribute	**Parameter**	**T**	**T Signif. @ P=0.05?**
Intercept	-0.138	-14.9	Yes
Difference in Price	-0.182	-20.8	Yes
Difference in Body Type	-0.537	-2.26	No
Difference in Body Type	-0.326	-2.17	No
Difference in Fuel Efficiency	0.0119	14.6	Yes
Difference in No of doors	-0.154	2.30	No
Difference in Fuel Type	-0.158	-1.92	No

Table 18: Text&Picture Experiment

Table 19 presents the model parameters and supporting regression output estimated from the response data collected using the stated preference experiment that presented the attribute 'vehicle appearance' only pictures, and all other attributes using text.

Picture Only Set			
$R^2 = 0.52$			
Attribute	**Parameter**	**T**	**T Signif. @ P=0.05?**
Intercept	-0.197	-18.7	Yes
Difference in Price	-0.181	-18.1	Yes
Difference in Body Type	0.159	0.847	No
Difference in Body Type	-0.108	-2.13	No
Difference in Fuel Efficiency	0.0194	16.6	Yes
Difference in No of doors	-0.453	-5.91	Yes
Difference in Fuel Type	-0.125	-1.32	No

Table 19: Picture Only Experiment

Interpretation of the regression output in light of the third research question is presented in the following section.

7.3 Interpretation and Evaluation of the Estimated Utility Models

This section aims to directly address the third research question presented within this research:

- *Does the choice strategy employed by respondents during stated preference experiments affect the estimated utility models, and resulting utility estimates?*

Chapter 6 identified differences in the choice strategies used by respondents within the different stated preference experiments implemented within this research, which used text only, text&picture, and pictures only to represent attributes. This section examines the utility models that were estimated from each of these three stated

preference experiments. Comparisons are made between the goodness of fit of each of the models and the estimated model parameters.

The 'goodness of fit' (the ability of the explanatory variables to explain variation in the independent variable) of each of the three estimated utility models is compared by examination of the R^2 terms associated with each of the regression models. The lower the level of the R^2 term associated with a model, the greater the level of variance in the inferred preferences of respondents undertaking the stated preference experiments. Section 7.3.1 examines any differences between the R^2 of the estimated models terms in relation to the choice strategies used by respondents during the different stated preference experiments.

The estimated parameters associated with each of the three estimated utility models are then examined. These are compared to determine whether their sign reflected that expected of the relationship between independent variables – where expectations were held. Furthermore the t values associated with each of the parameters were examined to determine whether the variable were significantly different from zero. It was considered likely that those attributes that were less commonly used within the choice process of a respondent would be more likely to produce variables that were not significantly different to zero, or having a parameter value with an unexpected associated sign. These attributes are those that would modally salient in the choice process. For example, body type was not identified in chapter 4 as an attribute that was modally salient in the car purchasing choice, however was included within the experiment because it was of interest to the designers of the new fuel-efficient vehicle. In chapter 6, this attribute was identified as being commonly ignored in the choice process by respondents during the stated preference experiment. Tests for differences in the estimated parameters for each of the three utility models are also examined and possible differences identified. The tests employed were two-tail t-tests (section 7.3.3) and also the estimation of a regression model for the whole data set, which included a dummy variable for the representation type of the stated preference experiment (section 7.3.4).

7.3.1 The Coefficient of Determination (R^2 term)

A commonly used measure of the goodness of fit of the linear regression model is the R^2 term, or the coefficient of determination. Draper and Smith (1998) state that the *'statistic is used almost universally in judging regression equations'*. The R^2 value measures the goodness of fit as a percentage of total variation in the dependent variable explained by the regression line. If all the points fall on the regression line, the value of R^2 is 1. As the independent variables explain less and less of the variation in the dependent variable then the value of R^2 falls to zero.

The three utility models estimated from the responses made by individuals in the three alternative stated preference experiments exhibit differing R^2 terms. The text only experiment has an R^2 value of 0.47, the text&picture experiment a value of 0.53, and the picture only experiment a value of 0.52. Whilst these values suggest that the models explain around only half of the variation in the response data, these values are

not low compared to typical R^2 values associated with utility models estimated from stated preference data (Swanson, 2000).

Low R^2 terms in the models estimated in this research and overall for all three samples might have resulted from differing preferences of individuals within each of the sample groups. Whilst all respondents from the stated preference experiments were individuals interviewed at Volkswagen showrooms, and interested in the purchase of a VW Golf, it is expected that preferences and reasons for purchasing a new vehicle would vary across the sample group.

However, as well as R^2 terms being generally low across all three samples, there is also some difference between the sample groups. In particular those sample that used pictures within the stated preference experiment exhibited slightly higher R^2 terms – with over 50% of the variation in the responses being explained by the estimated models. Suggested reasons for the differences in the R^2 terms between the experiments that used pictures, and the one that did not are:

- The respondents in the 'text only' sample might have held a greater level of preference variation than those within the other sample groups. However chapter 6 (section 6.2) explained that each of the three samples of respondents exhibited similar demographic proportions, which reduces (although does not remove) the possibility of there being large differences in the preference variation between the sample groups.

- A higher level of *perceived* preference variation was exhibited between the respondents *within* the 'text only' sample, because there was greater variation in the interpretation/comprehension of the attribute 'vehicle appearance' (represented by the intercept term in the models) within this sample, than those respondents that were presented choice scenarios that included pictures. This possibility is supported by Pearmain et al (1991) who suggests that it is more likely that qualitative attributes are comprehended differently if pictures are not used.

- Differences in the R^2 terms between the estimated utility models were identified which resulted from variation in the responses caused by differing choice strategies employed by the respondents.

The following section considers the estimated regression parameters, and their relative significance between the sample groups.

7.3.2 *Interpretation of the Model Parameters*

The model parameters presented in tables 17 to 19 were examined to determine whether their sign reflected that expected of the relationships between the independent and dependent variables – where expectations about a relationship were held. Furthermore the t-values associated with these parameters were examined to determine whether the model parameters were significantly different to zero. They show the percentage of certainty that each independent variable influences change in the dependent variable. The critical level of significance is P=0.05.

Price was expected to exhibit a negative relationship with utility – the higher the price of the ASCC (described in the experiment as the VW New) compared to the VW Golf, the lower the related utility of the ASCC. In all three models this negative relationship was reflected, as expected, as a negative parameter for the price variable. The t-statistic associated with the price variable was significant for all four of the models estimated.

Fuel efficiency was expected to exhibit a positive relationship with utility – with utility levels increasing with increases in the fuel efficiency. Again, in all three models, this expected relationship was shown – with the fuel efficiency variable exhibiting an associated positive parameter. All three models exhibit significant parameters for the fuel efficiency variable.

Whilst for some vehicles, 3-doors is the norm and considered attractive (for example in the sports car category), it was expected that consumers contemplating the purchase of a standard VW Golf would prefer a five door vehicle to a 3-door vehicle. This can also be inferred by the successful higher pricing of 5-door vehicles within the market. Within the stated preference design used within this research however, the ASCC was only presented as a 3-door vehicle, and differences in the number of doors between the two vehicles were reflected in changes to the attribute level for the VW Golf. This was because the unique aerodynamic styling of the ASCC is currently dependent upon a 3-door design. No plans for a 5-door vehicle are being considered. Therefore, the negative parameters displayed for this variable in the three models, reflects expected relationships – with 5 doors being valued more highly than 3. However, whilst the type of relationship might be considered as expected, these parameters should be treated with care, as the model parameters for three of the four models exhibit t-statistics that suggest that the parameters are of statistical insignificance. Only the co-efficient for the picture only sample exhibited a t-statistic that suggests a significant parameter. The low t-statistics associated with the text only and text&picture sample groups could be considered to be a result of differing preference of the individuals within the sample group, but also could be a result of the use of non-utility choice strategies by respondents within the stated preference experiments, where the attribute 'number of doors' was commonly ignored by respondents during their choice process.

All four models exhibit a negative parameter associated with fuel type, which suggests that on aggregate, individuals considered diesel vehicles to be of lower utility than petrol fuelled vehicles. None of the models however exhibited t-statistics that suggested the parameter was significantly different to zero. The low t-statistics associated with the parameter values of the fuel type variable may be a result of differences in the preferences held about the attribute by the respondents within the sample group. In the initial stage of research undertaken to elicit vehicle attributes considered by consumers in their decision to purchase a particular type of vehicle (described in chapter 4), there were some differing attributes held by respondents about what the fuel type of a vehicle meant for them. The low t-statistic associated with the parameter values might also be a result of the use of non-utility choice strategies by respondents within the stated preference experiments, where respondents commonly ignored the attribute 'fuel type' during their choice process.

All t-statistics associated with the parameters values of the variable representing 'body type' were low, and suggested that the parameter was **not** significantly different to zero. This is not an unexpected result, because within chapter 6, which identified the choice strategies employed by respondents during the think-aloud protocol, it was reported that respondents were not attributing any difference in utility from differences in body type. In the identification of choice strategies used by respondents in chapter 6, respondents commonly ignored the attribute 'body type' in the choice process. This attribute was also not elicited as a determining factor in the decision to purchase a new vehicle in the pre-stated preference data collection. It is therefore not surprising that the regression analysis has produced t-statistics for the parameters of this attribute that show them to be insignificant. This attribute was only included within the experiments' design because the ASCC's developers wanted to check that there wouldn't be an adverse consumer reaction to a vehicle constructed of a carbon compound.

The intercept term associated with each of the three stated preference experiments represents a constant difference between the two vehicles that is not represented by the difference in the two vehicles of those attributes that vary within the stated preference experiments: price, body type, fuel efficiency, number of doors, and fuel type. This constant difference that represents other variable includes the represented difference in the appearance of the vehicle. Negative intercept terms for each of the estimated models therefore suggested that respondents hold a lower value for the appearance (and other constant differences perceived between the vehicles) of the VW New (the ASCC) than the VW Golf, should there be no difference between the two cars for the other represented attributes. All three models present significant t-statistics associated with the intercept parameter estimates.

Overall, the parameters associated with the independent variables included within the regression model suggested a relationship that confirmed expectations for those variables that the researcher considered were understood. However, all of the t-statistics associated with model parameters (other than the intercept term, the attributes 'price' and 'fuel efficiency', and for the picture only sample the attribute 'number of doors') suggested that the parameters were not significantly different to zero. These low t-statistics may be a reflection of variation in the utility that respondents attach to attributes in question, or it may be a result of the choice strategies employed by the respondents during the stated preference experiments.

7.3.3 Comparing Differences Between Model Parameters

To determine whether differences between the different models described in section 7.2.6 are statistically significant, a set of two-tail t-tests were undertaken on the parameter values estimated for each model. It would be expected that there would be no significant differences between the utility model parameter values if the representation of attributes was unrelated to the responses made by individuals to the different experiments, given that each of the samples exhibited similar sample characteristics.

Table 20 below presents the parameter values for the models estimated from the text only, and text&picture samples. The resulting t-values from the two tail t tests are shown for each of the parameters. In the comparisons between the models estimated from these two sample groups, significant differences were found between the two models for all the estimated parameters.

Attribute	Parameter Values for Text	Parameter Values for Text&Picture	T-value	Significant difference at 0.05?
Intercept	-0.811	-0.138	63.10	yes
Difference in Price	-0.262	-0.182	-38.19	yes
Difference in Body Type	0.314	-0.537	-5.36	yes
Difference in Body Type	-0.266	-0.326	33.65	yes
Difference in Fuel Efficiency	0.017	0.0119	78.15	yes
Difference in No of doors	-0.049	-0.154	-70.93	yes
Difference in Fuel Type	-0.030	-0.158	-41.64	yes

Table 20: Testing for Significant Differences Between the Estimated Parameters for the Text and Text&Picture Samples

Table 21 presents the parameter values for the models estimated from the text only, and picture only samples. The resulting t-values from the two tail t tests are shown for each of the parameters. In the comparisons between the models estimated from these two sample groups, significant differences were found between the two models for all the estimated parameters apart from that associated with the attribute difference in body type.

Attribute	Parameter Values for Text	Parameter Values for Picture	T-value	Significant difference at 0.05?
Intercept	-0.811	-0.197	-57.54	yes
Difference in Price	-0.262	-0.181	36.71	yes
Difference in Body Type	0.314	0.159	0.07	no
Difference in Body Type	-0.266	-0.108	-30.90	yes
Difference in Fuel Efficiency	0.017	0.0194	-76.48	yes
Difference in No of doors	-0.049	-0.453	65.03	yes
Difference in Fuel Type	-0.030	-0.125	42.92	yes

Table 21: Testing for Significant Differences Between the Estimated Parameters for the Text and Picture Samples

Table 22 presents the parameter values for the models estimated from the picture only, and text&picture samples. The resulting t-values from the two tail t tests are shown for each of the parameters. In the comparisons between the models estimated from these two sample groups, significant differences were found between the two models for all the estimated parameters apart from those associated with the attributes difference in body type and difference in fuel type.

Attribute	Parameter Values for Picture	Parameter Values for Text&Picture	T-value	Significant difference at 0.05?
Intercept	-0.197	-0.138	5.70	yes
Difference in Price	-0.181	-0.182	-1.04	no
Difference in Body Type	0.159	-0.537	-5.64	yes
Difference in Body Type	-0.108	-0.326	3.45	yes
Difference in Fuel Efficiency	0.0194	0.0119	2.15	yes
Difference in No of doors	-0.453	-0.154	-6.33	yes
Difference in Fuel Type	-0.125	-0.158	0.91	no

Table 22: Testing for Significant Differences Between the Estimated Parameters for the Picture and Text&Picture Samples

According to these t-tests, all but three of the comparison made between the estimated parameter values exhibited significant differences between the sample groups. This analysis therefore tentatively supports the research undertaken by Nelson (1992; 1998) that suggests that the representation of attributes within stated preference experiments impact on the responses made by individuals, and the resulting estimated utility models.

Chapter 6 identified differences in the choice strategies employed by respondents within the different stated preference experiments implemented within this research, that use alternative ways to represent attributes. The differences between the estimated parameter values associated with the utility models derived from each of the three experiments might therefore support the existence of a relationship between the choice strategy employed by respondents and the resulting estimated utility model (research question 3). However, this relationship cannot be confirmed, as differences between the parameter values may have been caused by differences in preferences held by the individuals between the different sample groups, or alternatively, may result in differences in the way respondents perceive the attribute 'vehicle appearance' within the experiments, when represented in different ways.

The next section undertakes a further test to establish the impact of the attribute representation type (and therefore the associated choice strategies used by respondents) on the estimated utility models.

7.3.4 Determining the Impact of Attribute Representation Type (and Associated Choice Profile) on Estimated Utility Functions

Two models were estimated and compared to see if the results of the regression analysis were significantly influenced by the attribute representation type (and the associated choice strategies used by respondents):

- Regression analysis of the total response data set from all three stated preference experiments, against the vehicle attributes included as explanatory variables;
- Regression analysis of the total response data set from all three stated preference experiments, against the vehicle attributes included as explanatory variables *and*

including dummy variables that represent the attribute representation type of the stated preference experiment from which the response was elicited.

As discussed in section 7.2.4 dummy variables are useful for representing data that does not take the form of values over a continuous range. To represent attribute representation type within the regression model, three distinct levels need to be represented (text only, text&picture, and picture only). This was achieved using two dummy variables employed as follows:

$(X_1, X_2) = (1, 0)$ for text only
$= (0, 1)$ for picture only
$= (0, 0)$ for text & picture

where X_1 to X_2 are the dummy variables.

The first stage of the analysis of this data was to identify any improvement of fit in the regression equation. Whilst the R^2 value is one of the most commonly quoted values from regression analysis, there are some limitations in its interpretation when comparing regression models that differ in the number of explanatory variables. Albright et al. (2000) state that *'it can only increase when explanatory variables are added to an equation.. ...some of which have no conceptual relationship to the response variable'.* Albright et al (2000), and Draper and Smith (1988) suggest in this situation, that the Adjusted R squared term is also considered when this is the case. In the previous comparisons of the estimated regression models for the three sets of response data (from each of the three stated preference experiments), all the models estimated contained the same explanatory variables. Comparison of the models using R^2 was therefore appropriate. The two regression models compared within this section contain different explanatory variables (one contains dummy variables that correspond to the attribute representation type used in the stated preference experiments). It is important therefore that the Adjusted R^2 terms are also compared. The R^2 and Adjusted R^2 terms associated with the two estimated models are presented in table 23.

Model Type Estimated	R^2	Adjusted R^2
Full data set	0.382	0.381
Full data set variables for representation type	0.573	0.571

Table 23: R^2 and Adjusted R^2 terms for the Full Data Set Models

The R^2 value for the full data set increased from 0.382 to 0.573, with the inclusion of dummy variables for attribute representation type. At the same time, the adjusted R^2 squared increased from 0.381 to 0.571. Both these increases reflect large improvements in the amount of variation in the response data explained by the regression models. In deciding if the impacts of representation type on utility model estimation are statistically significant, an incremental F-test was used. The inclusion of the dummy variables associated with different ways of representing attributes resulted in an incremental F-statistic of 9.93. This F-statistic is significant at the $p = 0.05$ level. Attribute representation type therefore has a significant impact on the results of the stated preference experiments. As with the findings presented in section

7.3.2, this supports the research of Nelson (1993. 1998) that identified differences the responses and resulting utility models estimated from stated preference experiments that used different ways of representing attributes.

The findings presented within this section supports the existence of a relationship between the representation of attributes represented within a stated preference experiment and the resulting estimated utility model. However the impact of differences in the choice strategies used by respondents (associated with the different experiments using different ways of representing attributes) cannot be separated out (*research question 3*). The impact of experiment type on the model estimated within this section may have been caused by differences in preferences held by the individuals between the different sample groups, or alternatively, may result in differences in the way respondents perceive the attribute 'vehicle appearance' within the experiments, when represented in different ways.

7.4 Conclusion

Chapter 6 identified differences in the choice strategies used by respondents within the three different samples that were presented with stated preference experiments that used alternative ways of representing product attributes (*research questions 1 and 2*). This chapter aimed to identify differences between models estimated from the response data collected during the implementation of the three stated preference experiments, to identify a relationship between the choice strategies employed respondents, and the models estimated from responses made using these choice strategies (*research question 3*).

The stated preference response data collected during the three stated preference was used to estimate consumer utility models relating to the differences in vehicle attributes. The data was analysed using a logit transformation, and regression analysis to produce utility models with the vehicle attributes included within the stated preference experiment as explanatory variables. The use of non-utility maximising choice strategies by respondents was represented within the analysis, using Parker et al's 1976 method.

The models were examined in terms of their explanatory power, and their parameter values, to try and identify any differences. A number of differences between the sample groups were identified. The two sample groups that used pictures in the stated preference presentation exhibit higher levels of model fit than the model produced from the sample group that didn't include pictures. Furthermore, examination of the model parameter values found significant differences between all but three of the comparisons. The impact of the stated preference attribute representation type (and the associated choice strategy profile of the respondents) on the utility model estimation was also examined by comparing analysis of the full response data set with a model estimated from the full data set, with representation type included as dummy variables. This comparison suggested that attribute representation type has a significant impact on the results of the regression analysis (the utility models).

The analysis presented within this chapter might be interpreted to suggest that there exists a relationship between the utility model estimated from response data, and the choice strategies employed by respondents making those responses. However the choice of a research design that uses three different sets of respondents for each of the three stated preference experiments (justification of which is provided in chapter 3), means that identified differences between the responses (and models estimated from them) made from respondents in each of the sample groups, might be caused by:

- **Different sets of preferences held between the three different sample groups.**
  Whilst it is expected that there is variation in preferences across a sample group, if the variation differs between each of the sample groups then this will impact on the responses elicited for each of the sample groups and therefore the estimated model parameters.

- **Differences in the way the alternatively represented attributes were comprehended by the three different sample groups.**
  As one of the vehicles (the ASCC) represented in the choice scenarios presented to respondents was a vehicle that is not currently available or known in the marketplace, respondents who were shown the text only choice card may have held a different mental image of the vehicle described to those respondents who were presented a picture of the vehicle.

It is not possible therefore to single out the direct impact of the profile of choice strategies employed by each of the sample groups, on their responses and the estimated parameters of the resulting utility models estimated from the response data collected during the stated preference experiments within this research. The next chapter presents further investigation of the impact of differing choice strategies used by respondents in stated preference experiments, on the estimation of consumer utility models. This is achieved through the analysis of data simulated to represent responses made by employing choices strategies that mirror those made by individuals within each of the sample groups. The use of simulated data allows conditions of the experiment to be controlled, so that the direct impact of the choice strategies used by respondents on the resulting utility models can be examined.

CHAPTER 8: EXAMINING THE IMPACT OF DIFFERING RESPONDENT CHOICE BEHAVIOURS ON UTILITY MODEL ESTIMATION

CHAPTER 2:
Theoretical Background to the Research Area

CHAPTER 3:
Research Methodology and Design

CHAPTER 4:
Determining of Stated Preference Experiment Attributes

CHAPTER 5:
Design of the Stated Preference Fieldwork

CHAPTER 6:
The 'Think-Aloud' Interview

CHAPTER 7:
Analysis of Response Data

CHAPTER 8:
Examining the Impact Differing Choice Processes on Estimated Utility Models

- *Simulating Response Data, With Differing Assumptions About Respondent Choice Strategies*
- *Identifying the Impact of Alternative Respondent Choice Strategies on Estimated Model Parameters and Utility Values*

CHAPTER 9:
Conclusions

8.1 Introduction

The analysis presented in chapter 6 focused on the identification of the choice strategies employed by respondents in each of the three sample groups during the stated preference experiments *(research questions 1 and 2)*. As previously described, each of the sample groups was presented with different stated preference experiments where the attributes were represented in different ways (using pictures, text or picture&text to represent the attribute vehicle appearance). Chapter 7 then described the analysis of the response data collected during these stated preference experiments, in order to estimate and compare the utility models associated with each sample group *(research question 3)*. The analysis described in chapter 7 identified significant differences in the model parameters estimated using the response data from each of the sample groups associated with each experiment type. However as each of the sample groups are independent and represent different people, it is possible that these differences in the parameter values could result from differences in the preferences held by the respondents between the groups. Furthermore, these identified differences in the estimated utility models could have resulted from differing comprehension of the attributes contained within the experiments, when they were presented in different ways. From the analysis presented within chapter 7 therefore, it is not possible to single out the impact of the choice strategy profile of a sample group on the model estimated.

This chapter presents an investigation of the impact of differing choice strategies used by respondents in the stated preference experiments, on the estimation of consumer utility models. This is achieved through the analysis of data simulated to represent responses made by respondents employing choices strategies that mirror choice strategy profiles identified in chapter 6. The chapter firstly discusses the use of simulation techniques to create stated preference response data, and provides published examples of the technique that test the properties of stated preference experiments. The rest of the chapter then follows the analytical steps depicted in figure 21. Firstly the development of a simulation model is described that mirrors the choice strategy profiles identified in chapter 6 for each of the three sample groups to produce stated preference response data. The analysis of this response data to estimate consumer utility models is then described. Two alternative methods of data analysis are presented to assess which method achieves the most effective model estimation for responses made from non-utility maximising choice strategies. The next step in the analysis presented in this chapter identifies differences in the estimated utility models, in terms of the goodness of fit of the models, and differences in the parameter values between models *(addressing research question 3)*. Finally, the last step of the analysis identifies significant differences in the utility estimates between each of the utility models *(addressing research question 3)*.

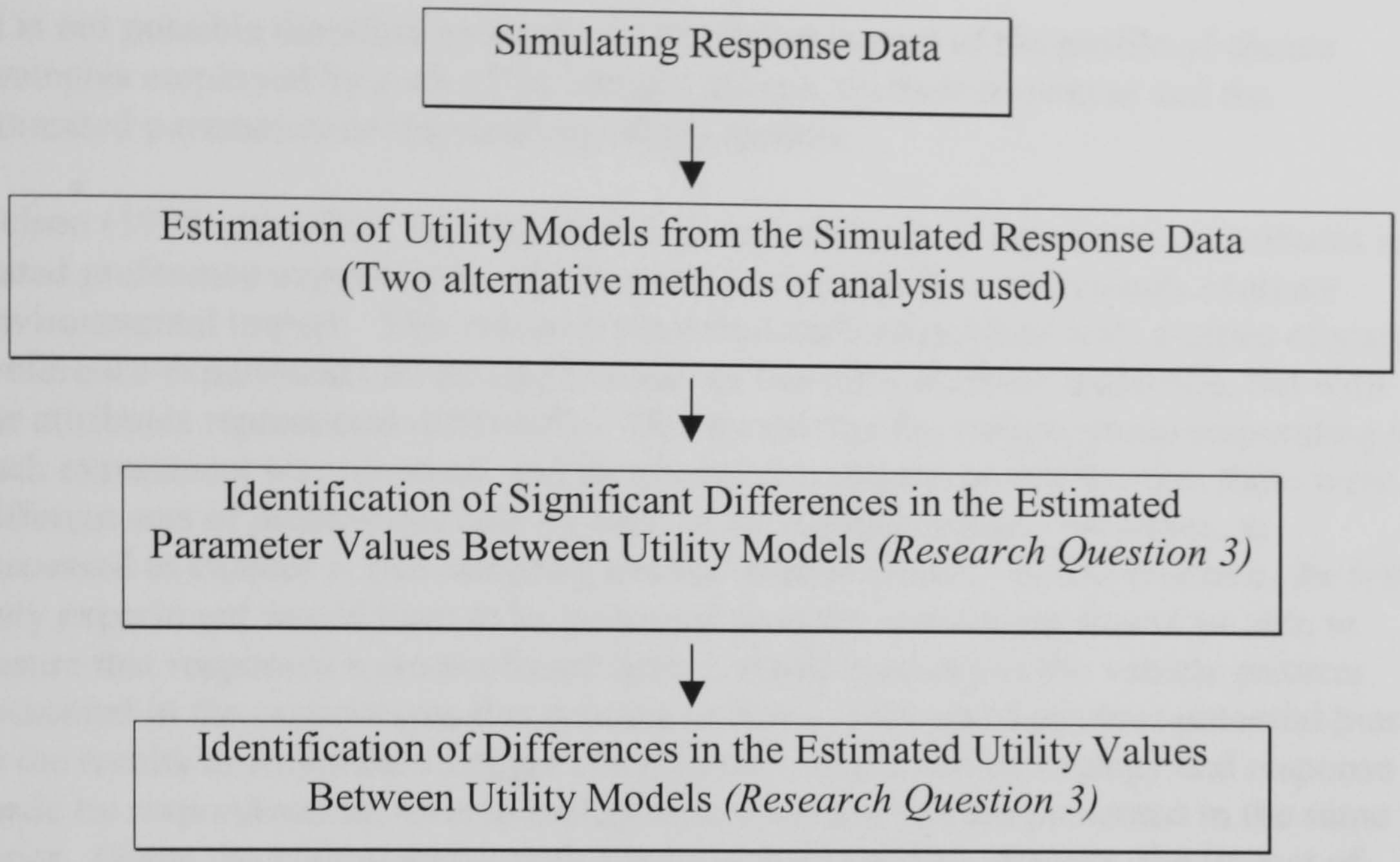


Figure 23: Structure of Simulated Response Data Analysis

8.2 Identifying the Impact of Differing Choice Strategies on Responses and Utility Model Estimation

Determining the impact of respondents using non-utility maximising choice strategies on responses in stated preference experiments, and the resulting parameters of the utility models *(research question 3)* is problematic. Chapter 7 identified significant differences between the parameters of the utility models associated with the three different sets of response data produced from the three alternative presentations of the stated preference experiments used in this research. However, as was discussed in the previous chapter, these identified differences may have resulted from:

- **Different sets of preferences held between the three different sample groups.**
  Whilst it is expected that there is variation in preferences across a sample group, if the variation differs between each of the sample groups then this will impact on the responses elicited for each of the sample groups and therefore the estimated model parameters.

- **Differences in the way the alternatively represented attributes were comprehended by the three different sample groups.**
  As one of the vehicles (the ASCC) represented in the choice scenarios presented to respondents was a vehicle that is not currently available or known in the marketplace, respondents who were shown the text only choice card may have held a different mental image of the vehicle described to those respondents who were presented a picture of the vehicle.

It is not possible therefore to single out the direct impact of the profile of choice strategies employed by each of the sample groups, on their responses and the estimated parameters of the resulting utility models.

Nelson (1998) examined the impact of different methods of representing attributes in stated preference experiments, which aimed to measure how individuals evaluate environmental impact. This research presented each respondent with a series of stated preference experiments all aiming to measure the same attribute trade-offs, but with the attributes represented differently. This meant that the sample group responding to each experiment was identical, and therefore removed the possibility that there were different sets of preferences held by each of the sample groups. However, as discussed in chapter 3, this sampling method is problematic. In this research, the text-only experiment would have to be presented to every respondent first to be able to ensure that responses were not based upon a stored memory of the vehicle pictures presented in the experiments that contain pictures. This could produce potential bias in the results as respondent fatigue could impact on the choice strategy and response made by respondents answering multiple experiments that are presented in the same order. Given the potential bias with adopting this sampling strategy, the impact of differing choice strategy profiles on responses, and resulting estimated utility models, is examined in this research by using simulation techniques.

Simulation is a modelling technique that allows the researcher to experiment with a model that represents the subject of interest, through the variation of the model inputs. Anderson et al (1998) state:

> *'The simulation model contains the mathematical expressions and logical relationships that describe how to compute the value of the output given the value of the inputs. Any simulation model has two inputs: controllable inputs and probabilistic inputs'*

This description of a simulation model is clearly depicted in figure 22, which is presented by Anderson et al (1998). The controllable inputs are set by the researcher, whilst the probabilistic inputs that are generated include some random element. The output of the model is then based upon these inputs and is observed for each run (or trial) of the simulation.

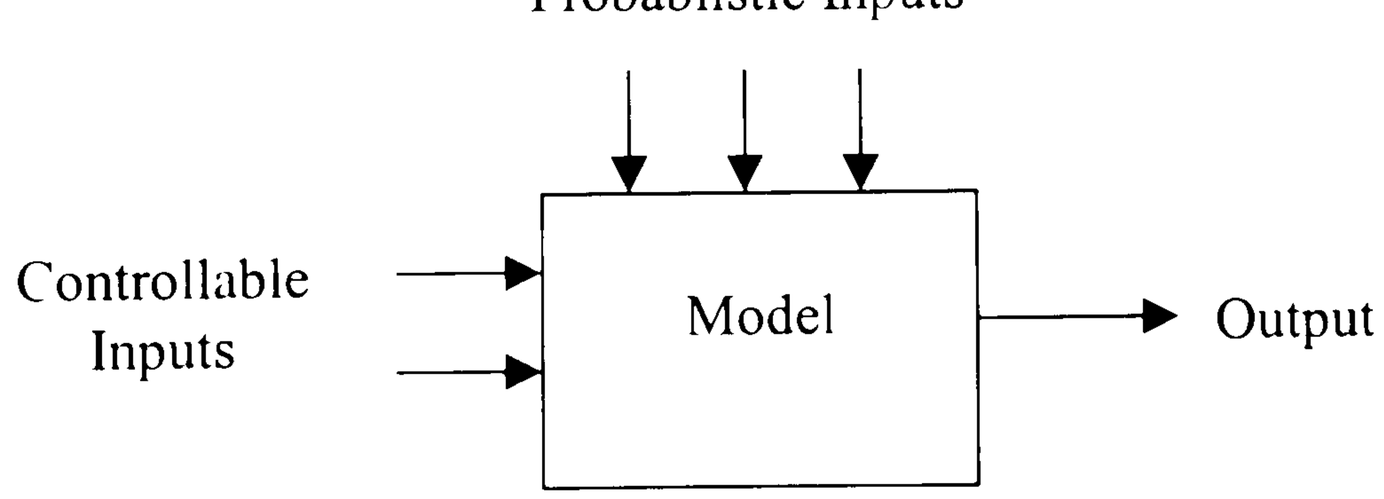


Figure 24: A Simulation Model (Anderson et al., 1998)

Simulation techniques are now widely used and accepted within the field of the social sciences and *'this is because simulation is an excellent way of modelling and understanding social processes'* (Gilbert and Troitzsch, 1999). Within the field of stated preference techniques, simulation has also been widely used to test the statistical properties of stated preference designs and analysis.

Cirrillo et al, (2000) who test alternative analytical techniques used in the analysis of stated preference data, also emphasise the ability of this method to allow systematic variation in the specification errors and other aspects of the choice under investigation. Watson et al (2000) also make use of simulation techniques to test the properties of orthogonal stated preference designs (discussed in chapter 5), whilst Bradley and Daly (2000) test the use of adaptive stated preference designs using simulated data (also discussed in chapter 5).

Simulation techniques are a widely accepted method for testing the statistical properties of stated preference designs and analytical techniques, and published examples of their use have been presented above. It is therefore considered an appropriate approach to test differences in the estimated utility models produced from different response data sets, simulated to represent different choice strategy profiles used by respondents in stated preference experiments (*addressing research question 3*). The next section describes how simulation techniques were used to simulate stated preference responses, using the choice strategies identified as being used by respondents in chapter 6 and the identification of differences between the utility models.

8.3 Simulation of Response Data

In the previous section, simulation models were described in terms of the controllable and probabilistic inputs to the model. The simulation models implemented in this research aimed to simulate the responses made by individuals within a stated preference experiment. The simulations mirror the stated preference designs and analyses of the experiments previously described in chapters 5 to 7. They therefore simulate the 16 choices presented to respondents within the stated preference experiments previously described, which presented the purchasing choice between two different vehicles.

Figure 23 below represents the simulation model employed in this research, and depicts the inputs (controllable and probabilistic), the utility model upon which the model is based, and the output – the simulated response of respondents within an stated preference experiment.

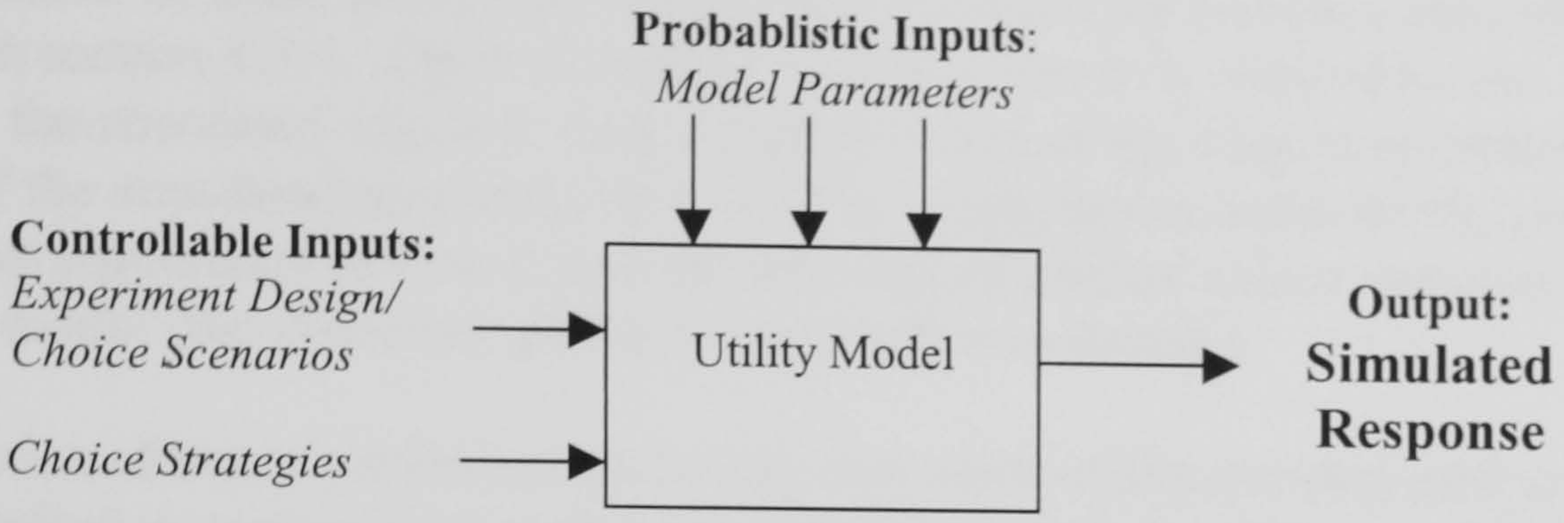


Figure 25: Simulating Stated Preference Responses (Adapted from Anderson et al., 1998)

The simulation process can be further understood when presented as a flow diagram, as shown in figure 24.

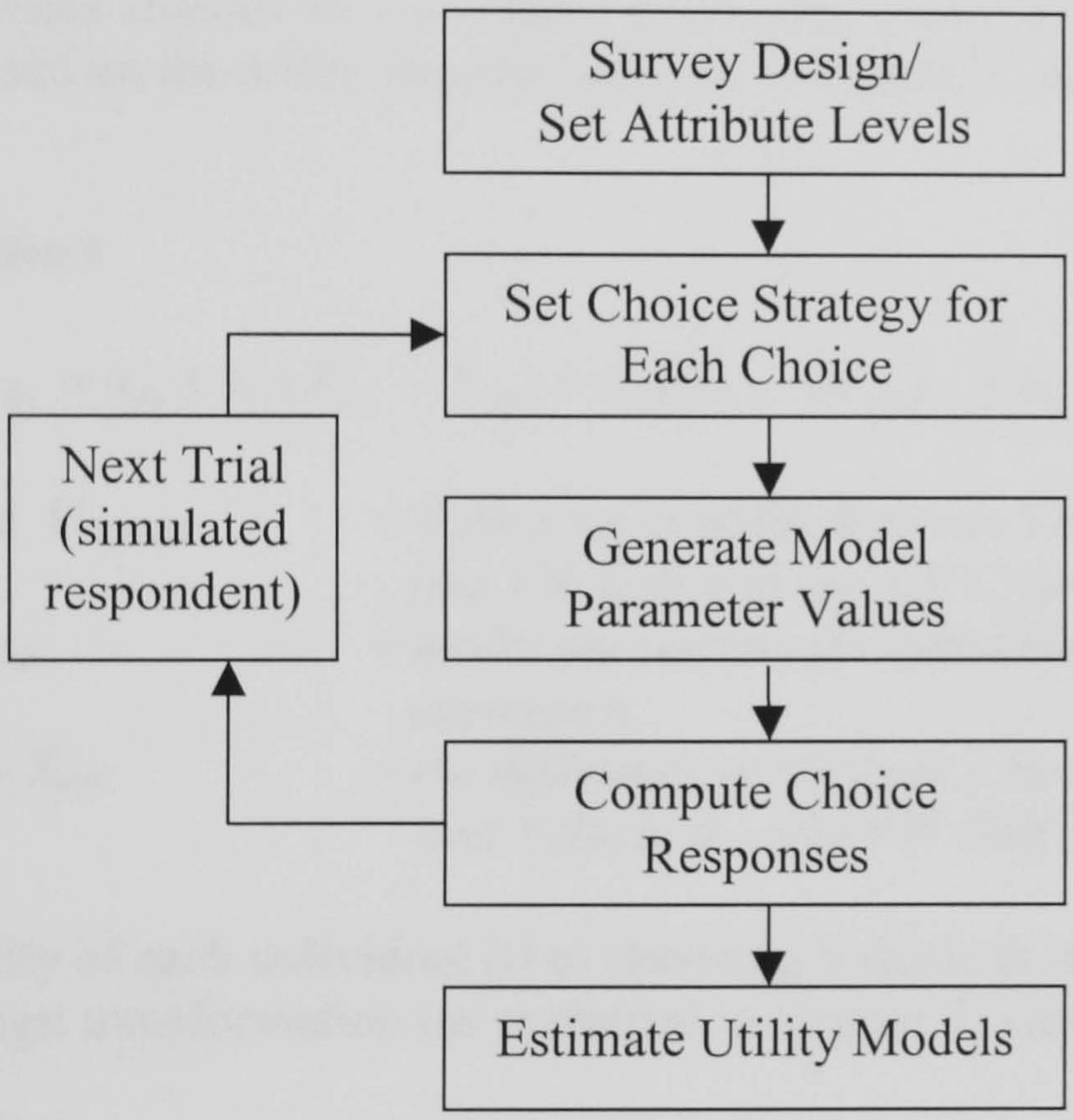


Figure 26: Flow Diagram of the Simulation Process

This figure shows the first step as the setting of the stated preference experiment design (a controllable input) – that is the attributes included within the experiment and their levels, which will remain the same for each of the simulation trials (simulated respondent). Secondly the choice strategy assumed is set for each choice scenario within the experiment, for each trial (simulated respondent). The assumed choice strategy is different for each trial (simulated respondent) but is still controlled by the researcher to reflect the choice strategies used by respondents for each of the three sample groups – as identified in chapter 6. The next step is the generation of parameter values for the utility model used within the simulation. As the parameter values held by each individual respondent are unknown this is considered to be a probabilistic input. This probabilistic input contains random elements that represent varying preferences by respondents across a sample, and also a response error term . These parameter values are defined later in section 8.3.3). The fourth step calculates

the choice responses for each trial (simulated respondent). This simulation is repeated until the number of trials (simulated respondents) reached the level required (this is discussed in section 8.3.4. Once the sample size is of the level desired by the researcher, the simulated response data is analysed and utility models estimated. Analysis of the simulated responses then enables a comparison between the estimated utility model parameters obtained, and the assumed parameter values inputted into the simulation model (the efficiency of the stated preference design).

The simulation of stated preference responses described above and depicted in figure 24 are described in section 8.3.1 to 8.3.4 that follow, whilst the analysis of this response data (the estimation of utility models) is discussed in section 8.4.

8.3.1 The Adopted Utility Model

Stated preference choices for the vehicle purchasing choice experiments were simulated based on the utility function adopted in chapter 7, and is presented as follows:

Equation 5

$$U_{i(A-B)} = a_{i0} + a_{i1}(X_{1A} - X_{1B}) + a_{i2}(X_{2A} - X_{2B}) \ldots + a_{in}(X_{nA} - X_{nB}) + e_i$$

where $U_{i(A-B)}$ = *difference in utility between Vehicle A and Vehicle B (the VW Golf and the ASCC)for individual i*

$a_{i0} \ldots a_{in}$ = *model parameters for individual associated with attribute n*

$X_{nA} - X_{nB}$ = *the difference in attribute n between Vehicle A and Vehicle B (the VW Golf and the ASCC)*

The probability of each individual (i) of choosing Vehicle B is provided by the following Logit transformation (as explained in chapter 7, section 7.2.3):

Equation 6

$$P_{iB} = \left\{ \exp U_{iA-B} / \exp(1 - U_{iA-B}) \right\}$$

Where U_{iA-B} = $a_0 + a_1(X_{1A} - X_{1B}) + a_2(X_{2A} - X_{2B}) \ldots\ldots + a_n(X_{nA} - X_{nB})$

$a_0 \ldots a_1$ = *model parameters*

$X_{nA} - X_{nB}$ = *the difference in the attribute n between vehicle A and B*

Choices were simulated to mirror the choices presented to respondents during the stated preference experiments described in chapters 5 to 7 of this thesis and responses calculated using the following steps:

1. Calculate a total utility score associated with the choice scenario
2. Transform the utility score into a Logit probability, which takes a number from a continuous scale

3. Identify the response probability from the 5-point response scale used in the experiment, which is most closely related to the Logit probability determined in step 2.

The total utility score associated with the choice scenario was calculated using assumed parameter values (described in section 8.3.3 that discusses probabilistic inputs), and the appropriate respondent choice strategy (described in detail in section 8.3.2) and the utility function presented in equation 5. This calculated utility score was then transformed into a logit probability (using equation 6) that represents the simulated respondents probability to choose the VW Golf or the ASCC (described in the experiment as the VW New). These simulated probability values were then compared to the five-point probability scale that was presented to respondents in the stated preference experiments described in chapters 5 and 7 (and is presented again here in figure 24). The probability value from the scale that was closest to that of the simulated probability value was selected and recorded as the simulated response.

Definitely Choose the VW Golf	Probably choose the VW Golf	No preference	Probably Choose the VW New	Definitely choose the VW New
0.1	0.3	0.5	0.7	0.9

Table 24: Scaling of Choice Probabilities

The following section described the controllable inputs into the simulation.

8.3.2 Controllable Inputs: Experiment Design and Choice Strategies

The controllable inputs into the simulation, were described in the section 8.3 as those elements that are under the control of the researcher, and were identified as:

- The design of the stated preference experiment
- The choice strategies employed by the respondents in each of the three sample groups

The design of the stated preference experiment refers to the specific vehicle attributes and their levels described in each of the 16 choice scenarios presented to each respondent during an experiment. These attribute levels, for the 16 choice scenarios, were set at the same levels as in the stated preference experiments described in chapters 5 to 7. The specific attribute levels are presented in table 5, in section 5.4.3.

As stated above, the simulation also included as a controllable input, the choice strategy employed by each respondent. The choice strategies employed by each respondent, during each choice scenario, in each of the three stated preference experiments implemented as part of this research were identified and described in chapter 6 of this thesis. The model described in this chapter aims to simulate these choice strategies used in the three experiments exactly.

Chapter 7 described the analysis of stated preference response data, where the choices had been made by respondents using three alternative choice strategies:

1. *Utility maximising choice strategies* are those usually assumed by stated preference practitioners. This means that respondents are believed to attach weightings to each/all of the attributes in a choice situation. It is assumed that the option with the highest total utility will therefore be chosen.

2. *Lexicographic choice strategies* are those used when a person hierarchically orders all the attributes of choices they are about to make and then chooses the alternative with the highest value on the most important attribute. Here again, travel choices of this type are easy to find, for example the person for whom travel time is critical will choose the quickest journey over all other attributes.

3. *A hybrid choice strategy*: This was where a combination of utility maximising and lexicographic choice strategies were employed. Respondents hierarchically order groupings of attributes, and then employ a utility maximising choice strategy to the highest value grouping of attributes.

These different choice strategies were simulated within the model described in this chapter by transforming the variables included within the simulation to reflect the respondent`s use of information during the choice process as follows:

- *Utility maximising choice strategies:* all variables included within the model reflected the differences between variables presented in the experiments. This therefore suggests that all information presented to a respondent was included in the choice process.

- *Lexicographic choice strategies and hybrid choice strategies*: Variables that represented attributes not considered by respondents in their choice strategy were set to zero. This reflected the lack of influence that these variables had on the measure of response from the choice scenario.

The choice strategies included within the model for each respondent (simulation run/trial) can be considered as a controllable input as these were set to reflect those choice strategies identified as used by respondents to the stated preference experiments described in chapters 5 to 7 of this thesis.

8.3.3 Probablistic Inputs: Representing the Model Parameters

The model parameters represent the value, or weightings, which respondents attach to the difference in attribute levels of the two vehicles, presented to a respondent during the stated preference experiments. This section describes how the assumed parameter values, and then the associated error terms associated with each choice were determined to represent realistic choice scenarios.

Artificial sets of preferences (model parameters) were assumed in order to simulate utility levels for each simulated respondent`s choice. Three utility models were

estimated in chapter 7 from the sets of response data from the three stated preference experiments (presented in table 25). The estimated parameter values from these models were used as the assumed parameter values for different simulations. Using these homogonous parameter values for all respondents, and all choices, to determine utility scores for the simulations, would represent responses from a sample with:

- No variation in preferences across the sample and
- No level of response error from the respondents making the choices

However Pearmain et al (1991) and Bradley and Daly (2000) suggest that random components should be incorporated within the simulated responses if the simulation aims to reflect more realistic choices. Pearmain et al (1991) suggests both the inclusion of an *'error term for each simulated 'respondent' should be drawn at random from an appropriate statistical distribution'* and that *'other utility terms (the coefficient attached to each attribute) can also be drawn randomly, assuming a mean and standard deviation for each coefficient'*. Bradley and Daly (2000) suggest that the random component included as a respondent error term relates to *'taste variation within the sample related to unmeasured or non-included variables'* whilst random components relating to each of the parameter values (parameters attached to each attribute) *'represents 'taste variation' in the sample which relates to the included variables'*.

The level of preference (taste) variation between the respondents within the stated preference experiments described in chapter 7 is unclear. Response variation between respondents, resulting in models with low R^2 terms associated with the estimated utility models could have been caused from preference variation between respondents. However the variation could also have been explained by differences in respondent's comprehension of attributes presented in the stated preference experiments or difference in choice strategies used by respondents.

Within the simulations presented in this chapter random components were included reflecting variation in preferences (taste) within the sample. Whilst the true preference variation of the sample groups was not identified or known, it is difficult to quantify the level of variation that should be built into the simulation. The random components built into the simulation, were uniform for all the data sets being created. Therefore comparisons *between* the simulated models should not be distorted by any inaccuracy in the assumed level of variation.

The random components that were built into the simulated response data was based upon guidelines presented in a published example of a simulation of stated preference responses by Bradley and Daly (2000). These simulations contained:

- Error terms that were represented by a random number. These were represented by an extra random error component specific to each individual, drawn from a normal distribution with mean 0 and standard deviation 0.5.

- Parameter values that included a random component. Instead of fixed parameters for the model variables, parameters were drawn separately for each

individual from a normal distribution with standard deviation equal to half the mean.

Table 25, presents the assumed parameter values derived from the estimated utility models presented within chapter 7. These values relate to the three models that were derived from the response data collected from the three alternative stated preference experiments, where attributes were represented in three ways:

- Text only
- Text&Picture
- Picture only

		'Text only' parameter values	'Text&Picture' parameter values	'Picture only' parameter values
Intercept	Mean	-0.811	-0.334	-0.197
	Standard Deviation	0.4055	0.167	0.0985
Difference in Price	Mean	-0.262	-0.206	-0.181
	Standard Deviation	0.131	0.103	0.0905
Difference in Body Type	Mean	0.314	-0.163	0.159
	Standard Deviation	0.157	0.0185	0.0795
Difference in Body Type	Mean	-0.266	-0.521	-0.108
	Standard Deviation	0.133	0.2605	0.054
Difference in Fuel Efficiency	Mean	0.017	0.0165	0.0194
	Standard Deviation	0.0085	0.00825	0.0097
Difference in No of doors	Mean	-0.049	-0.173	-0.453
	Standard Deviation	0.0245	0.0865	0.2265
Difference in Fuel Type	Mean	-0.030	-0.0405	-0.125
	Standard Deviation	0.015	0.02025	0.0625

Table 25: Assumed Parameter Values and their Level of Variation Within the Simulations

The next section describes the size of the simulation, resulting from alternative data sets simulated using these different sets of assumed parameters.

8.3.4 Size of Simulation

Each simulated response data set was created to reflect:

- The three alternative sets of assumed model parameters to be used within the simulations. As described at the beginning of this section these were derived from the estimated models presented in chapter 7 that described the analysis of the stated preference response data.

- Three different sets of choice strategies that mirror the choices strategies employed by respondents in the three stated preference experiments described in chapters 5-7 (these inputs were described previously in section 8.3.2 of this chapter).

In each simulated data set, the number of trials (simulated responses) was:

40 simulated respondents	**X**	**16 simulated choice cards**	**=**	**640 simulated choices**

This mirrors the sample, and experiment size of the stated preference experiments described in chapters 5 to 7.

The total number of data sets created was 9, which was made up from:

3 different choice strategy profiles	**x**	**3 different sets of assumed model parameters**	**=**	**9 data sets**

The formation of these 9 sets of simulated response data is also depicted in figure 25 below. This shows how data sets were simulated from three different sets of assumed parameter values, 'text only', 'text&picture' and 'picture only'. As previously described, these parameter values are those estimated in chapter 7 from the data collected from the three stated preference experiments implemented in this research (as described in chapter 7).

Three sets of response data were simulated from each of the three sets of parameter values assumed. Each of these sets of data were simulated by assuming choice strategies employed by respondents that mirrored those identified in each of the three experiments as described in chapter 6. In total this results in a total of 9 sets of simulated response data.

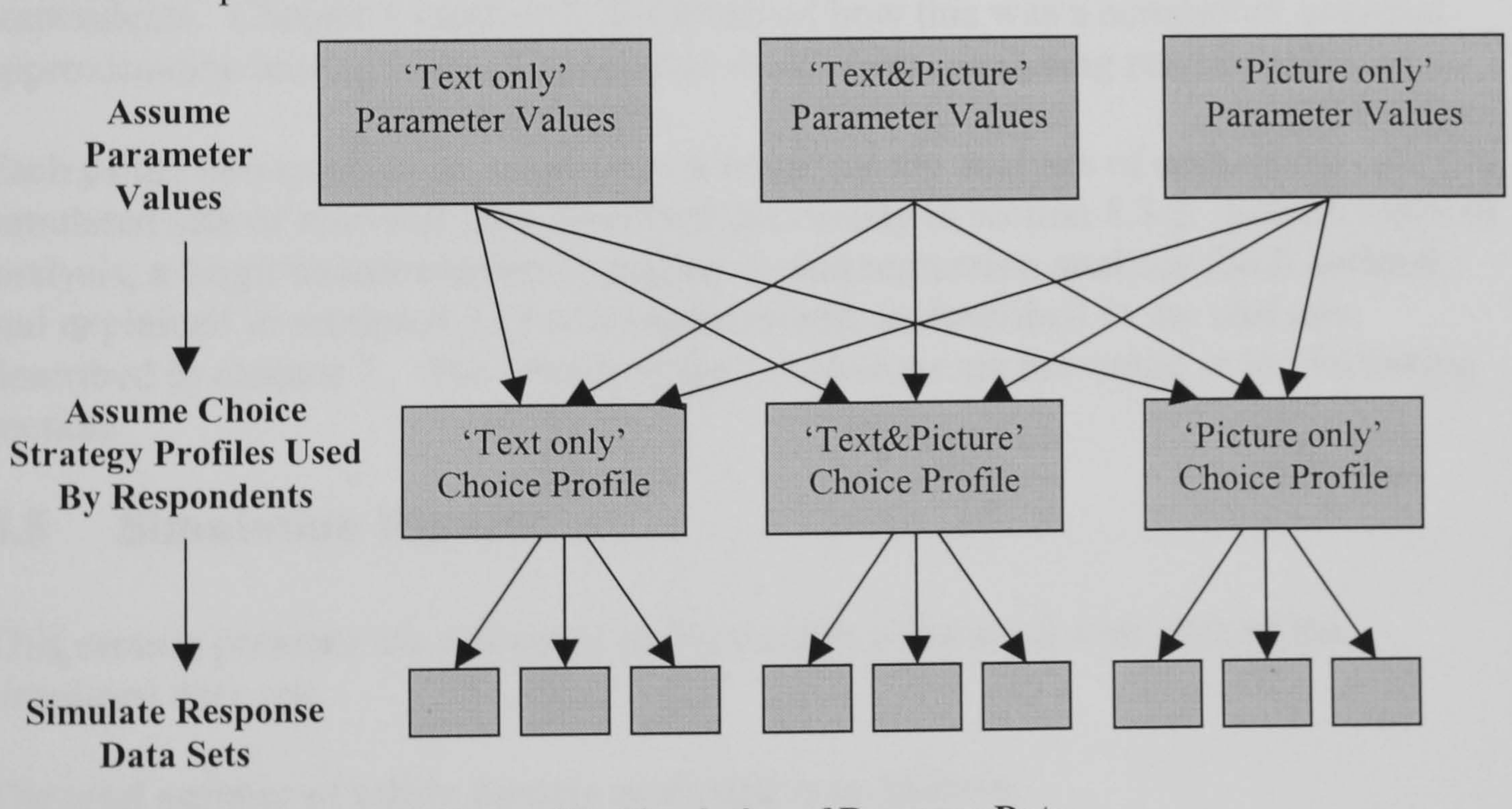


Figure 27: Simulation of Response Data

The following section discussed the analysis of these simulated sets of stated preference response data.

8.4 Analysis of the Simulated Response Data

The simulated response data for the 18 data sets described in section 8.3.4 was analysed in two different ways:

- **Assuming that respondents used a utility maximising choice strategy**: This meant that all differences between attribute levels represented within each of the choice strategies were related to the simulated response associated with each choice

- **Assuming that respondents adopted the choice strategies identified as being used within the stated preference experiments described in chapter 6**. This analysis mirrors that described in chapter 7 (described in section 7.2.4). Only those differences between attributes presented in the choice scenario that were identified as being used by the respondent were related to the simulated response for each choice.

These two alternative assumptions were made so that later comparison can be made between the estimations made using the two differing assumptions. This comparison is considered useful in order to determine whether the assumption that respondents use utility maximising choice strategies is an appropriate approximation for the analysis of response data elicited though non-utility maximising choices from respondents. Chapter 1 (section 1.3) explained how this was a commonly assumed approximation amongst stated preference researchers, analysing response data.

Each of the two types of assumption was made for the analysis of each of the simulated sets of response data described previously in section 8.3.2. In both types of analysis, a Logit transformation (equation 6) and regression analysis (both defined and explained in section 8.3.1) was implemented, as described in the analysis described in chapter 7. The results of the simulations are presented in the following section.

8.5 Simulation Results

This section presents the estimated utility models associated with each of the simulated data sets.

The total number of utility models estimated is as follows:

3 different choice strategy profiles	x	**3 different sets of assumed model parameters**	x	**2 alternative methods of analysis**	=	**18**

Tables 26 to 26 present the estimated model parameters for the utility models described above. A brief explanation of the models estimated in each table is provided. Section 8.6 then continues to described differences in the goodness of fit of each of the estimated models, before the chapter continuing to identify any significant differences in the parameter values in the estimated utility models that represent alternative choice strategy profiles used by the three different sample groups. Section

8.6 then continues to identify differences in the estimated parameter values and associated estimated utilities between the simulated data sets that are analysed using the assumption that respondents are using a utility maximising choice strategies, and those that assume the choice strategies previously identified in chapter 6.

		Utility Maximising Choice Strategy Assumed During Analysis			Identified Choice Profile Represented During Analysis		
Parameter	**Assumed Parameter Values**	**Text**	**Text& Picture**	**Picture**	**Text**	**Text& Picture**	**Picture**
Intercept	-0.811	21.43767	35.65187	32.16843	-1.46133	-1.22738	-1.24922
Difference in Price	-0.262	5.349548	8.92857	8.040698	-0.20689	-0.28192	-0.28477
Difference in Body Type (Dummy variable)	0.314	-56.2209	-91.9259	-83.0832	0.182398	0.386686	0.309119
Difference in Body Type (Dummy variable)	-0.266	-23.4287	-37.7053	-34.1917	-0.28157	-1.06208	-1.0292
Difference in Fuel Efficiency	0.017	0.02534	0.025334	0.025435	0.03492	0.024643	0.024819
Difference in No of doors	-0.049	-0.27322	-0.35194	-0.35205	-0.88881	-0.3627	-0.32687
Difference in Fuel Type	-0.03	-0.07088	0.032648	-0.03119	-0.118	0.025482	0.051681

Table 26: 'Text' Assumed Parameter Values

Table 26 presents the models parameters estimated from the simulated response data that used the 'text only' assumed parameter values. The models estimated from the response data through analysis that assumed utility maximising choice strategies were employed, show particularly large differences to the assumed values for the estimation of each of the model's intercept term, and the parameters associated with the attributes 'difference in price' and difference in body types.

		Utility Maximising Choice Strategy Assumed During Analysis			Identified Choice Profile Represented During Analysis		
Parameter	**Assumed Parameters**	**Text**	**Text& Picture**	**Picture**	**Text**	**Text& Picture**	**Picture**
Intercept	-0.334	217.8255	214.7967	32.16843	-1.67769	-2.10698	-2.06879
Difference in Price	-0.206	54.87157	54.09534	8.040698	-0.17635	-0.13663	-0.13771
Difference in Body Type (Dummy variable)	-0.163	-550.036	-542.334	-83.0832	0.110504	0.207386	0.111634
Difference in Body Type (Dummy variable)	-0.521	-220.502	-217.51	-34.1917	-0.20333	-0.6869	-0.64392
Difference in Fuel Efficiency	0.0165	0.025422	0.024136	0.025435	0.034087	0.024763	0.025014
Difference in No of doors	-0.173	-0.28773	-0.24578	-0.35205	-0.83347	-0.28034	-0.32871
Difference in Fuel Type	-0.0405	0.520007	0.515447	-0.03119	0.004265	0.365106	0.372956

Table 27: 'Text&Picture' Assumed Parameter Values

Table 27 presents the models parameters estimated from the simulated response data that used the 'text&picture' assumed parameter values. The models estimated from the response data through analysis that assumed utility maximising choice strategies were employed, again show particularly large differences to the assumed values for the estimation of each of the model's intercept term, and the parameters associated with the attributes 'difference in price' and difference in body types. These differences between the assumed and estimated parameters are much larger for the models that assume utility maximising choice behaviour, compared to those models that were estimated with the identified choice strategies represented within the analysis.

		Utility Maximising Choice Strategy Assumed During Analysis			**Identified Choice Profile Represented During Analysis**		
Parameter	**Assumed Parameter Values**	**Text**	**Text& Picture**	**Picture**	**Text**	**Text& Picture**	**Picture**
Intercept	-0.197	66.38997	83.5413	78.83321	-0.97909	-1.51187	-1.38935
Difference in Price	-0.181	16.73615	21.05229	19.86847	-0.26275	-0.20169	-0.20801
Difference in Body Type (Dummy variable)	0.159	-169.356	-212.448	-200.656	0.280009	0.287052	0.238641
Difference in Body Type (Dummy variable)	-0.108	-67.961	-85.2145	-80.4439	-0.33533	-0.22353	-0.32008
Difference in Fuel Efficiency	0.0194	0.034553	0.03444	0.034231	0.030866	0.034275	0.033394
Difference in No of doors	-0.453	-0.93507	-0.91296	-0.93953	-1.02702	-0.91534	-0.97229
Difference in Fuel Type	-0.125	-0.08301	0.025339	-0.00733	-0.01273	-0.03315	-0.12972

Table 28: 'Picture' Assumed Parameter Values

Table 28 presents the models parameters estimated from the simulated response data that used the 'picture only' assumed parameter values. The models estimated from the response data through analysis that assumed utility maximising choice strategies were employed, again show particularly large differences to the assumed values for the estimation of each of the model's intercept term, and the parameters associated with the attributes 'difference in price' and difference in body types.

Differences between the R^2 terms, the parameter values and the utility estimates associated with the models estimated using different assumed choice profiles are examined in the next section. This aims to determine whether differences in the choice strategy profile adopted by respondents in stated preference experiments affects the accuracy of the estimated utility models.

8.6 Identifying Differences Between the Utility Models Estimated From Simulated Data

8.6.1 Identifying Differences Between the Utility Models Estimated From Simulated Data – An Overview

The following sections compare the utility models estimated from the different sets of response data that have been simulated using three different assumed choice strategy profiles. As has been previously explained, these choice strategy profiles are the set of choice strategies identified as being used by each of three samples of respondents that were presented with the three stated preference experiments implemented in this research. These stated preference experiments represented the attribute vehicle appearance in three different ways: using text only, text&picture, and pictures only.

By examining any differences between the utility models estimated from these three types of simulated responses, and it is possible to identify the impact of respondents using differing choice strategies on the models estimated from their responses *(therefore addressing research question 3)*.

- **Goodness of fit (R^2)** – The R^2 terms of the utility models are examined to determine whether differing choice strategy profiles impact on their explanatory power.

- **Differences in the parameter values for models estimated from response data that was simulated using different choice strategy profiles** – The parameter values of the different models are examined to determine whether differences in the choice strategy profile of a sample has a significant impact on the estimated model parameters.

- **Differences in the parameter values for models estimated using differing assumptions about the choice strategies used by respondents during the analysis of stated preference response data** – Stated preference researchers/practitioners commonly employ the assumption that respondents use utility maximising choice strategies during the analysis of stated preference response data (Pearmain et al., 1991; Swanson, 1998). By comparing models that use this utility maximising assumption, and those that represent the identified choice strategies within the analysis, it is possible to identify the more appropriate analytical approach.

- **Examination of the utility values estimated from models derived from the different simulated data sets.** There is some discussion within the stated preference literature that suggests that inaccurate estimation of parameter values in utility is of limited important, because it is the overall estimation of utility values from these parameter values that is often required by stated preference researchers (Pearmain et al., 1991; Swanson, 1998; Louviere, 2000). This research also therefore compares the utility values derived from the models estimated from the different sets of simulated data.

The examination of the models derived from the different simulated response data sets therefore provides an understanding of the implications of the choice strategies identified as being used by respondents during the stated preference experiments, in terms of the analytical assumptions employed to estimated utility models, and the model outputs themselves. The next section begins by evaluating the goodness of fit of the estimated utility models.

8.6.2 Evaluating the Goodness of Fit of the Estimated Utility Models Using R^2 terms

Chapter 7 described how a commonly used measure for the goodness of fit of a regression model is the R^2 term, or the parameter of determination. Of the three different utility models examined in chapter 7, which represented the stated preference experiments that were presented in different ways (text, text&picture, and picture), differences were identified between the these R^2 terms. The 'text only' model exhibited an R^2 term of 0.47 whilst the 'picture&text' model, and the 'picture only' model exhibited R^2 terms of 0.52 and 0.53 respectively. Suggested reasons for the differences in the R^2 terms between the experiments that had used pictures, and those that had not, were presented in chapter 7 as:

- The respondents in the 'Text only' sample held greater level of preference variation than those within the other sample groups. Chapter 7 explained that each of the three samples of respondents exhibited similar demographic proportions, which reduces (although does not remove) the possibility of there being large differences in the preference variation between the sample groups.

- A higher level of preference variation was exhibited between the respondents *within* the 'Text only' sample, because there was greater variation in the interpretation of the attribute 'Vehicle Appearance' (represented by the intercept term in the models) within this sample, than those respondents that were presented choice scenarios that included pictures.

- Differences in the R^2 terms between the estimated utility models were identified which resulted from variation in the responses caused by differing choice strategies employed by the respondents.

By simulating data that has a uniform level of preference variation for each sample group, differences in the R^2 terms associated with the utility models presented in this chapter can be attributed to differences in the choice strategies assumed to be used to make simulated responses in each sample group.

The R^2 terms associated with the utility models estimated from the simulated response data derived from the 'text only' parameter values, are presented in table 29 along side the R^2 terms associated with the three utility models estimated from the response data collected in the stated preference experiments (presented in chapter 7). Both sets of models were estimated in the same way, with the identified choice strategies used by respondents being represented within the analysis (as explained in section 8.4).

Sample	R^2 Values	
	Derived from Elicited Response Data	Derived from Simulated Data ('Text only' Parameter Values Assumed)
Text only	0.4743	0.8229
Text&Picture	0.5290	0.8231
Picture only	0.5218	0.8190

Table 29: The R^2 Terms Associated With the Estimated Utility Models

The three R^2 terms associated with models estimated from the simulated response data (presented above) are higher than those associated with the models estimated in chapter 7. This suggests that the response data analysed in chapter 7 exhibited higher levels of variation within the response data than the variation simulated within the response data described in this chapter. It is however, the differences *between* the models estimated from the simulated response data that is of particular interest. Each of the models was based on simulated responses that assumed equal preference variation across the sample. Therefore, differences in the R^2 terms between these three models can be attributes to differences caused by the differing choice strategy profiles that were used to simulate the response data.

All three utility models estimated from the simulated data have very similar R^2 terms associated to them. This suggests that differences in the assumed choice strategy profiles do not therefore affect the goodness of fit of the estimated utility models. Further examination of the R^2 terms associated with the utility models estimated from the 'text&picture' and 'picture only' parameter values, also found only small differences (these are presented in Appendix H). This implies that differences in the R^2 terms associated with the models estimated from the response data analysed in chapter 7, are not caused by differences in the choice strategy profile used by each of the three groups.

The next section tests for differences between the estimated parameter values associated with the utility models estimated from the simulated response data, again looking for differences that result from the use of differing choice strategy profiles for each sample group.

8.6.3 Differences between the Estimated Model Parameters For Alternative Assumed Choice Profiles

Chapter 7 presented the utility models estimated from the three sets of response data, collected from the three alternative stated preference experiments, and highlighted significant differences between the estimated model parameters between the three. In section 8.2 however, possible reasons for differences in these parameter values were presented as each of the three sets of response data were collected from three independent sample groups. Differences in the parameter values were considered to be a result of:

- Different sets of preferences held between the three different sample groups.
- Differences in the way the alternatively represented attributes were comprehended by the three different sample groups.
- Differences in the choice strategy used by respondents in the choices presented to them during the stated preference experiment.

Section 8.3 described the simulation of three sets of response data that – for each set of assumed parameter values. The only differences in the simulation of these data sets, for each set of parameter values, was the assumed choice strategies used by respondents (the choice strategy profile of the data set). Significant differences found between the parameter values estimated for the utility models of these different response data sets would therefore suggest that different choice strategy profiles for a sample group do affect the resulting estimated utility models.

Table 30 to table 32 present a series of two-tail t-tests conducted to test whether a statistically significant difference exists between the estimated parameters found for the utility models estimated from the simulated response data that assumed the 'text only' model parameters. The two models compared in table 30 were estimated from responses simulated to represent two of the identified choice strategy profiles identified in chapter 6:

- 'Text only' choice strategy profile
- ''Text&Picture' choice strategy profile

All of the comparisons made between the parameter values, identified significant differences at the critical level of significance of p= 0.05.

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	'Text only' Choice Strategy Profile	'Text&Picture' Choice Strategy Profile		
Intercept	-1.46133	-1.22738	-63.10	yes
Difference in Price	-0.20689	-0.28192	-38.19	yes
Difference in Body Type	0.182398	0.386686	-5.36	yes
Difference in Body Type	-0.28157	-1.06208	-33.65	yes
Difference in Fuel Efficiency	0.03492	0.024643	78.15	yes
Difference in No of doors	-0.88881	-0.3627	-70.93	yes
Difference in Fuel Type	-0.118	0.025482	-41.64	yes

Table 30: Testing the Differences Between the Estimated Parameters ('Text' and 'Text&Picture' Choice Strategy Profiles)

The two models compared in table 31 were estimated from responses simulated to represent two of the identified choice strategy profiles identified in chapter 6:

- 'Text&Picture' choice strategy profile
- 'Picture only' choice strategy profile

The comparisons made between the parameter values were found to be significantly different for five of the variables included within the model. However the parameters

associated with the variables 'difference in price' and 'difference in fuel type' was not found to be significantly different.

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	'Picture' Choice Profile	Text&Picture' Choice Profile		
Intercept	-1.24922	-1.22738	-5.70	yes
Difference in Price	-0.28477	-0.28192	-1.04	no
Difference in Body Type	0.309119	0.386686	5.64	yes
Difference in Body Type	-1.0292	-1.06208	3.45	yes
Difference in Fuel Efficiency	0.024819	0.024643	2.15	yes
Difference in No of doors	-0.32687	-0.3627	-6.33	yes
Difference in Fuel Type	0.051681	0.025482	0.91	no

Table 31: Testing the Differences Between the Estimated Parameters ('Picture' and 'Text&Picture' Choice Strategy Profiles)

The two models compared in table 32 were estimated from responses simulated to represent two of the identified choice strategy profiles identified in chapter 6:

- 'Text only' choice strategy profile
- 'Picture only' choice strategy profile

The comparisons made between the parameter values were found to be significantly different for six of the variables included within the model. However the parameter for one of the dummy variables associated with 'difference in body type' was not found to be significantly different.

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	'Picture' Choice Profile	'Text' Choice Profile		
Intercept	-1.24922	-1.46133	-57.54	yes
Difference in Price	-0.28477	-0.20689	-36.71	yes
Difference in Body Type	0.309119	0.182398	0.07	no
Difference in Body Type	-1.0292	-0.28157	-30.90	yes
Difference in Fuel Efficiency	0.024819	0.03492	76.48	yes
Difference in No of doors	-0.32687	-0.88881	-65.03	yes
Difference in Fuel Type	0.051681	-0.118	-42.92	yes

Table 32: Testing the Differences Between the Estimated Parameters ('Picture' and 'Text' Choice Strategy Profiles)

Two tail t-tests for the parameters values of the utility models estimated from the other simulated data sets (representing other assumed choice parameters) are included within Appendix I. These tests also highlight a high level of parameter values that are significantly different between utility models that represent alternative choice strategy profiles.

Given that most of the parameters compared in tables 31 to 33 above, and those in Appendix G do show a significant difference between the sample groups, there is some evidence to suggest that differing choice strategies being used by respondents might cause significantly different estimated parameters in utility models. This suggests that the differences between parameters identified in chapter 7 may have

been caused, at least in part, by the choice strategies used by the respondents within those sample groups.

The next section considers the impact on the estimated parameter values of assuming the use of utility maximising choice strategies as an approximation during the analysis of stated preference response data.

8.6.4 Differences between Estimated Parameters Under Different Assumptions about Choice Behaviour

In the estimation of utility models, the assumption that respondents employ utility maximising choice strategies is commonly employed during the analysis of stated preference response data (Swanson, 1998; Louviere et al, 2000; Ampt et al, 1995;2000). The validity of this assumption was questioned in chapters 1 and 2 of this thesis, in light of research evidence from the field of psychology and recent questioning in the field of stated preference research, that suggests that individuals often use alternative choice strategies in their decision making process. The research findings presented within chapter 6 also identified non-utility maximising choice strategies being employed by respondents during the stated preference experiments implemented as part of this research. This section examines the impact of assuming utility maximising choice behaviour by respondents as an approximation during the analysis of stated preference response data. This is achieved through the examination of the model parameters estimated from response data analysed in two ways:

- **Assuming that respondents used a utility maximising choice strategy**: This meant that all differences between attribute levels represented within each of the choice strategies were related to the simulated response associated with each choice

- **Assuming that respondents adopted the choice strategies identified as being used within the stated preference experiments described in chapter 6.** This analysis mirrors that described in chapter 7 (described in section7.2.4). Only those differences between attributes presented in the choice scenario that were identified as being used by the respondent were related to the simulated response for each choice.

Table 33 to 35 present a series of two-tail t-tests conducted to test whether a statistically significant difference exists between the estimated parameters found for the utility models estimated from the simulated response data in the two ways described above.

Table 33 presents the comparisons made between the models estimated using:

- Response data simulated using the 'text only' assumed parameters
- Data simulated to mirror responses made using the 'text only' choice strategy profile.

All the comparisons made between the estimated parameter values showed significant differences.

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	Representing the Identified Choice Profile Within the Analysis	Assuming Utility Maximising Choice		
Intercept	-1.46133	21.43767	26681.18	yes
Difference in Price	-0.20689	5.349548	42434.51	yes
Difference in Body Type	0.182398	-56.2209	-24727.89	yes
Difference in Body Type	-0.28157	-23.4287	-11669.60	yes
Difference in Fuel Efficiency	0.03492	0.02534	-637.49	yes
Difference in No of doors	-0.88881	-0.27322	625.45	yes
Difference in Fuel Type	-0.118	-0.07088	43.98	yes

Table 33: Testing the Differences Between the Estimated Parameters for the 'Text' Choice Strategy Models (Comparing Alternative Methods of Analysis)

Table 34 presents the comparisons made between the models estimated using:

- Response data simulated using the 'text only' assumed parameters
- Data simulated to mirror responses made using the 'text&picture' choice strategy profile.

All the comparisons made between the estimated parameter values showed significant differences.

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	Representing the Identified Choice Profile	Assuming Utility Maximising Choice		
Intercept	-1.22738	35.65187	1271.44	yes
Difference in Price	-0.28192	8.92857	1386.87	yes
Difference in Body Type	0.386686	-91.9259	-10428.02	yes
Difference in Body Type	-1.06208	-37.7053	-1559.18	yes
Difference in Fuel Efficiency	0.024643	0.025334	43.88	yes
Difference in No of doors	-0.3627	-0.35194	-47.73	yes
Difference in Fuel Type	0.025482	0.032648	-24.58	yes

Table 34: Testing the Differences Between the Estimated Parameters for the 'Text&Picture' Choice Strategy Models (Comparing Alternative Methods of Analysis)

Table 35 presents the comparisons made between the models estimated using:

- Response data simulated using the 'text only' assumed parameters
- Data simulated to mirror responses made using the 'picture only' choice strategy profile.

All the comparisons made between the estimated parameter values showed significant differences.

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	Representing the Identified Choice Profile	Assuming Utility Maximising Choice		
Intercept	-1.24922	32.16843	35536.71	yes
Difference in Price	-0.28477	8.040698	57818.36	yes
Difference in Body Type	0.309119	-83.0832	-33492.93	yes
Difference in Body Type	-1.0292	-34.1917	-18758.92	yes
Difference in Fuel Efficiency	0.024819	0.025435	48.00	yes
Difference in No of doors	-0.32687	-0.35205	9.89	yes
Difference in Fuel Type	0.051681	-0.03119	-46.39	yes

Table 35: Testing the Differences Between the Estimated Parameters for the 'Picture Choice Strategy Models (Comparing Alternative Methods of Analysis)

Comparisons of the parameters estimated for utility models derived from different assumed parameter levels are included within Appendix J. *All* comparisons between parameter values estimated from the two alternative assumptions made during the analysis of the response data identified significant differences. This implies that the use of an assumed utility maximising approximation during the analysis of stated preference response data can result in significant differences in the resulting estimated utility models.

8.6.5 Implications of Identified Differences in Parameter Values

Examination of the utility models estimated from different data sets, and using different analytical assumptions relating to the use of different choice strategy profiles identified a number of significant differences in the estimated parameters of the utility models. However, Green and Srivinsen (1978) suggest that differences in the parameter estimates have little impact on the validity of the predictive abilities of the estimated utility models, if the utility estimates produced from these models are accurate for the attributes values within the range of interest to the researcher.

To assess the impact of the identified differences in the estimated model parameters on the use of stated preference experiments, the impact of these differences on resulting utility estimates are identified. The following section compares the utility values estimated from the alternative estimated utility models, for a series of different attribute levels.

8.7 Identifying the Accuracy of Utility Estimates from Estimated Models

8.7.1 Accuracy of Utility Models for Estimated Models Representing Alternative Sample Choice Profiles

This section compares the utility values estimated from the alternative assumed utility models from which each of the sample response data sets was simulated, for a series of different attribute values, against the utility values determined from the alternative models estimated from the simulated response data.

To compare utility estimates, it is necessary to assume attribute values for input into the estimated utility models. Many of the design features of the ASCC (described as the VW New in the stated preference experiments) are fixed – the fuel type, the number of doors, and the carbon body type. However given that the vehicle has not yet been developed as a full sized prototype, the values for the attributes that represent continuous data ('difference in price' and 'fuel efficiency') are uncertain. Utility values were therefore estimated for a series of values for the two variables associated with the attributes 'difference in price' and 'difference in fuel efficiency'.

Table 36 presents the 'base case' attribute values assumed for estimation of consumer utility levels, including estimated values for the variables representing the attributes difference in price and difference in fuel efficiency.

Attribute	Attribute Values
Difference in Price	The ASCC to be higher in price than the VW Golf by £6,000
Difference in Body Type	A steel bodied VW Golf, whilst a carbon bodied ASCC
Difference in Fuel Efficiency	The ASCC to be exhibit a fuel efficiency higher than that of the VW Golf by 80 mpg
Difference in No of Doors	The VW Golf to have 5 doors, whilst the ASCC has only 3 doors
Difference in Fuel Type	For there to be no difference in fuel type between the vehicles (i.e. both vehicles have petrol engines)

Table 36: Assumed Attribute Values for Utility Estimation

Figure 26 depicts the estimated utility for varying values for the difference in price (between the ASCC being £10,000 less than the VW Golf, and the ASCC being £10,000 more than the VW Golf). All other attributes were held at assumed constant 'base case' values, as presented in table 35.

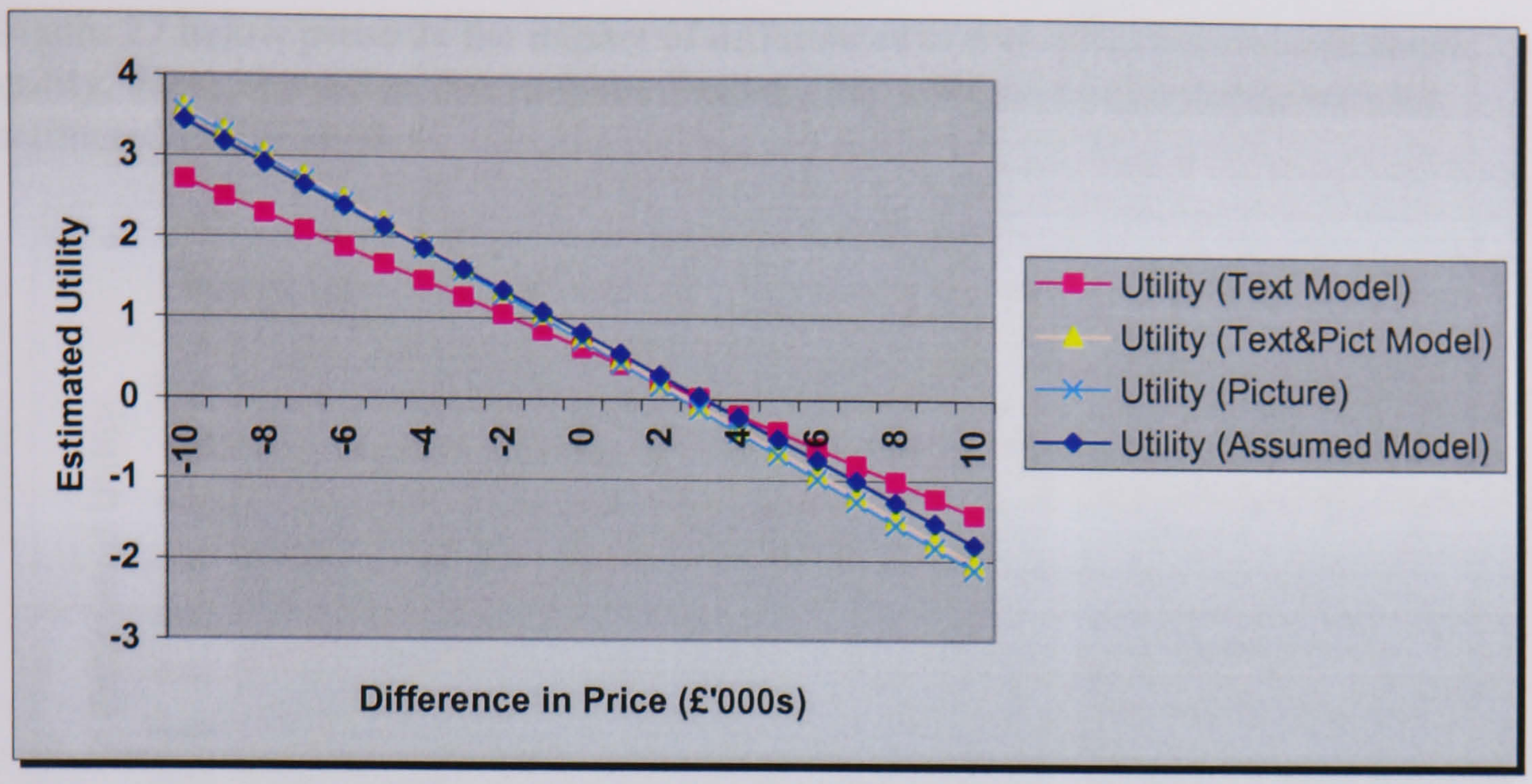


Figure 28: The Impact of Differences in Price on Utility Estimates (Assumed 'Text Only' Parameter Values, Analysis Using Identified Choices)

All four utility models present a negative relationship between the difference in price and estimated utility. The utility model based on data simulated using the 'text only' choice strategy profile exhibits the largest difference in its utility estimate when compared with the assumed model. The difference between the utility estimates produced from the estimated utility models, and the assumed model, can be seen more easily in figure 26.

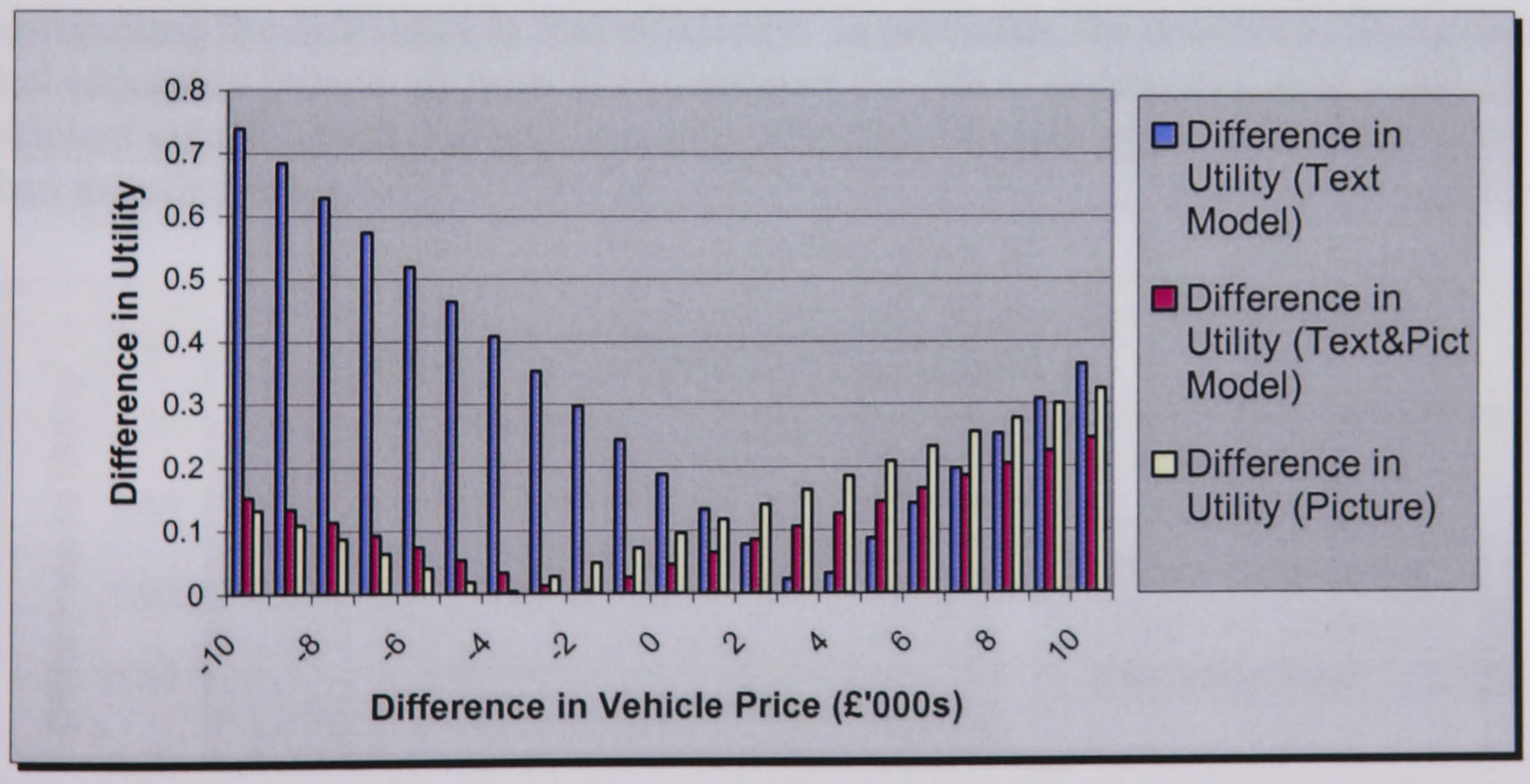


Figure 29: Impact of the Difference in Vehicle Price on the Difference in Utility Estimates (Assumed 'Text Only' Parameter Values, Analysis Using Identified Choices)

The differences in utility estimates for each of the estimated models shown in figure 26 are symmetrical around the point where the estimated model produced the same utility estimate as the assumed model. This is because the variable 'difference in vehicle price' has a linear relationship with utility, in all of the models.

Figure 27 below presents the impact of differences in fuel efficiency on estimated utility. Here, the difference in fuel efficiency has a positive relationship with the estimated utility level.

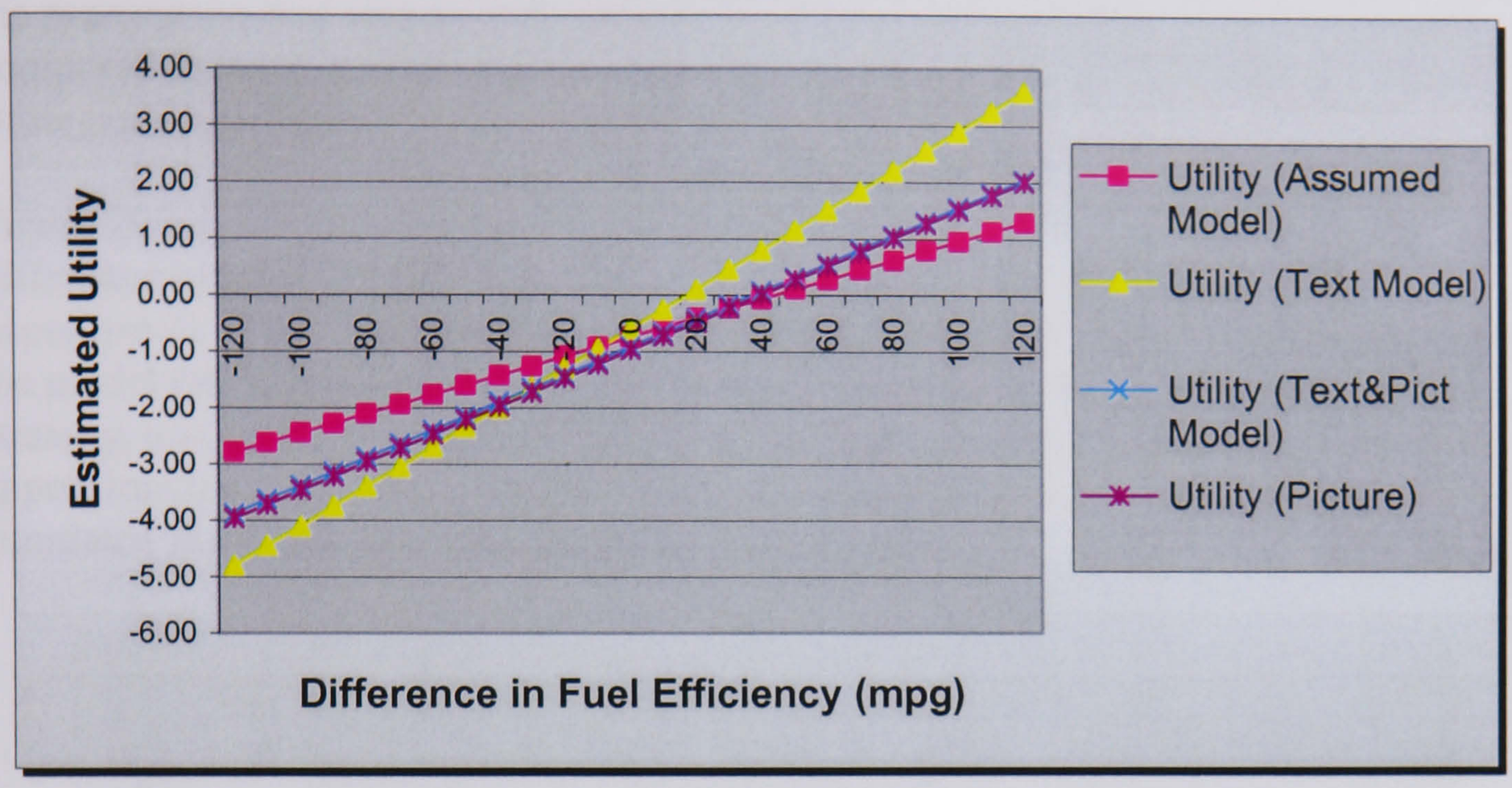


Figure 30: The Impact of Differences in Fuel Efficiency on Utility Estimates (Assumed 'Text Only' Parameter Values, Analysis Using Identified Choices)

The level of difference associated with the estimated utility levels, and the assumed values are shown in figure 28 below. Again the 'text' only model can be seen to exhibit higher levels of difference than the other model estimates, for most values representing the difference in fuel efficiency. In particular, for positive differences in fuel efficiency (which are most likely, because the ASCC is designed to be a fuel efficient vehicle), then the 'text' model produces differences in the estimates higher than the other models.

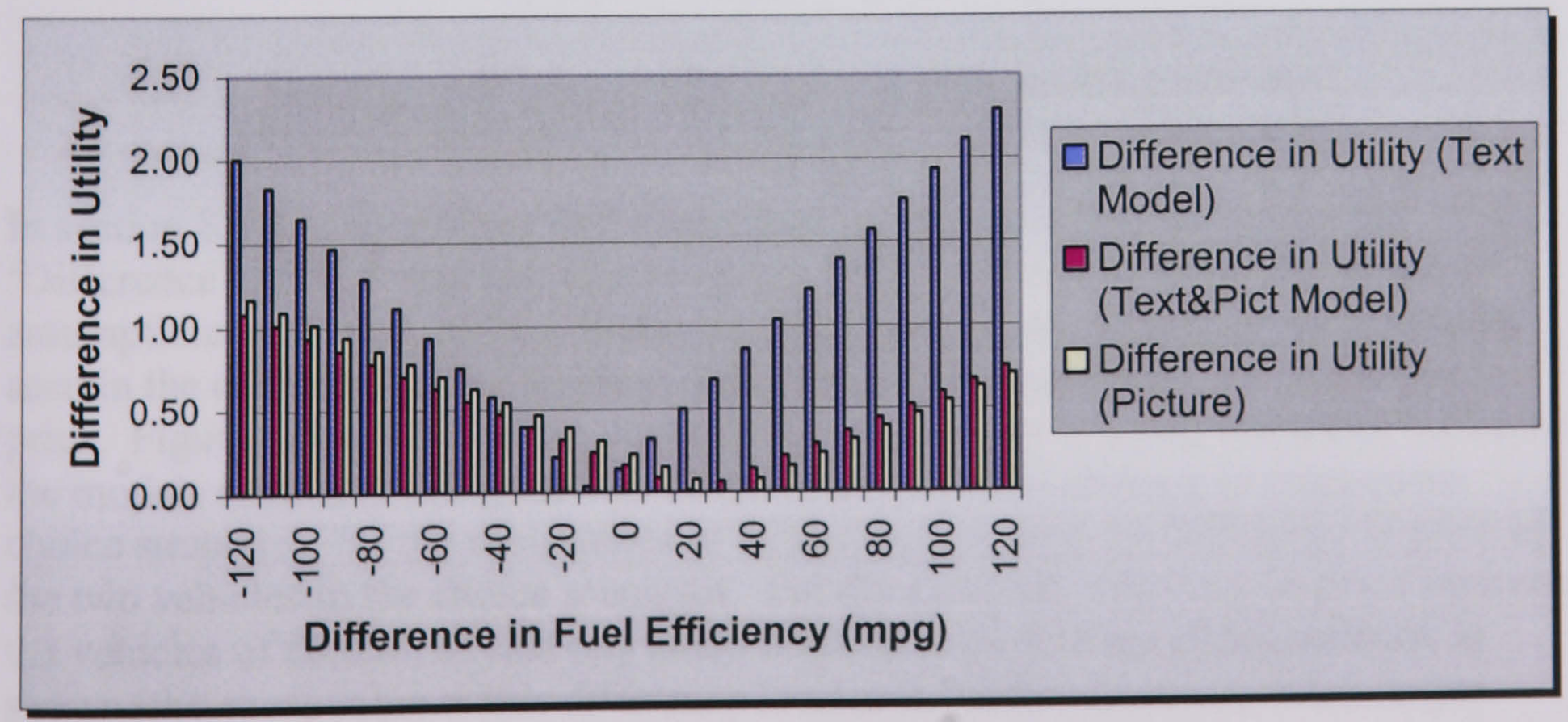


Figure 31: Impact of the Difference in Fuel Efficiency on the Difference in Utility Estimates (Assumed 'Text Only' Parameter Values, Analysis Using Identified Choices)

8.7.2 Differences in Utility Estimates Derived from Models Estimated Using Different Assumptions Relating to Respondent Choice Strategies

This section identifies differences in the utility estimates from models estimated using the assumption that respondents are using a utility maximising as an approximation, compared to those models estimated by analysing the response data with the choice strategies identified.

Figure 29 below presents utility estimates for a series of values representing the difference in price between the vehicles represented within stated preference experiments. The figure depicts the utility values estimated from the assumed model, the model that was estimated from simulated response data using identified choice strategy, and the model that was estimated using the assumed utility maximising approximation. All three of these models were estimated from response data simulated assuming the 'text' choice strategy profile.

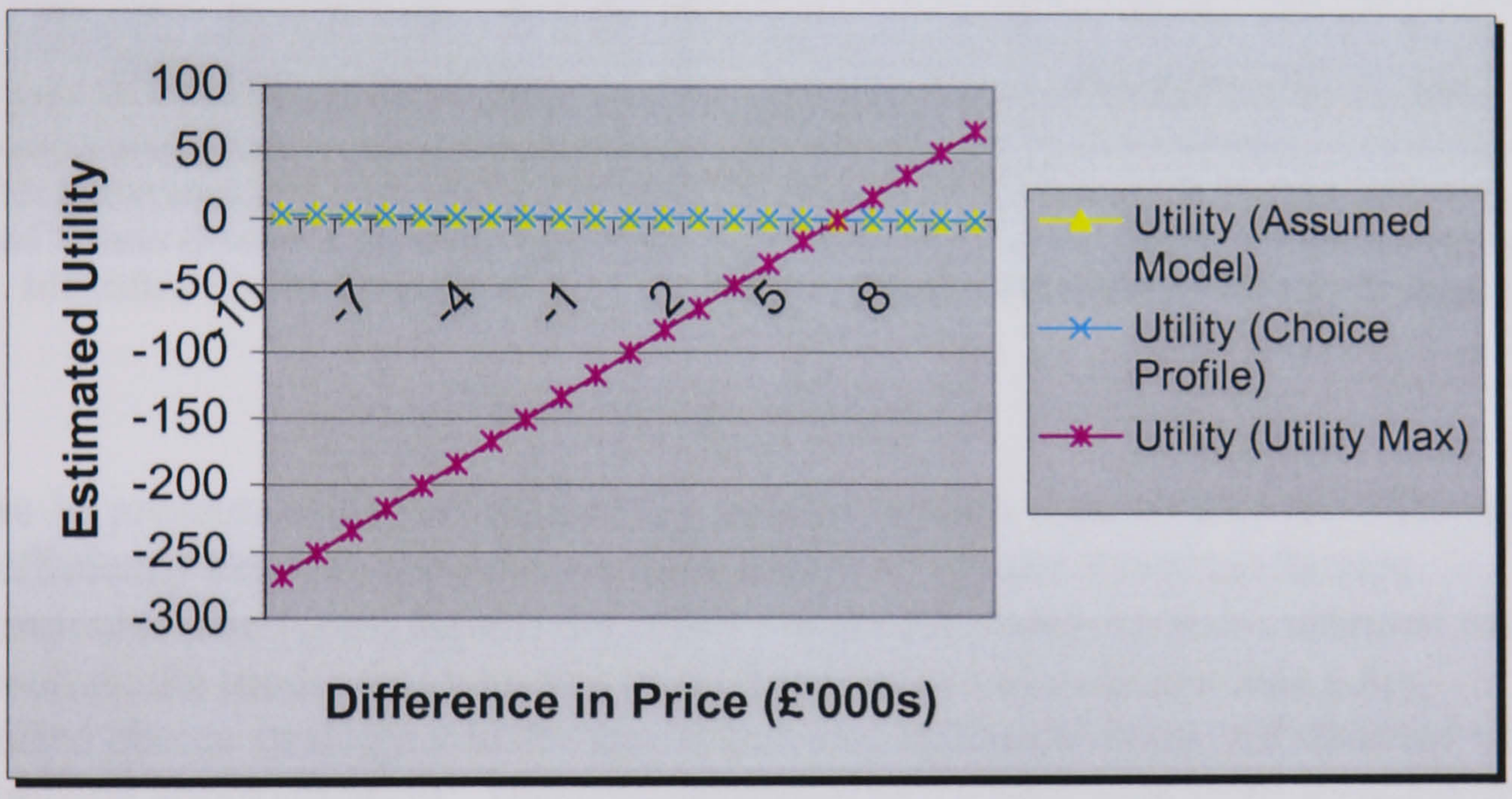


Figure 32: The Impact of Differences in Price on Utility Estimates (Assumed 'Text Only' Parameter Values, 'Text only' Choice Profile)

In section 8.6.4, a significant difference between the estimated parameter for 'Difference in Price' was identified between models estimated using the different assumptions relating to choice strategies. This significant difference can clearly be seen in the estimated utility levels at different assumed values for the difference in price. Figures 30 and 31 below, compare the differences in utility estimates between the models estimated using the two different assumptions relating to respondent choice strategies, for the same series of values representing the difference in price of the two vehicles in the choice scenarios. For the assumed difference in price between the vehicles of £6,000, a relatively small level difference in the utility estimate is shown (the exact value at this difference level is 0.1425). However, much larger differences is the estimated utility values can be seen for the model which uses the assumption for utility maximising approximation if the difference in price level is much higher, or lower, than this value.

The difference in the utility estimates from the model using a utility maximising approximation are extremely large, and so are presented on a separate figure to the utility estimates for the model that represented the identified the choice strategy profiles within the estimation process. Examination of the differences in utility estimate for the two types of model suggests that for the estimated £6,000 difference in price between the ASCC and the VW Golf, and within the range of prices around this estimate, differences in the utility estimates compared to the assumed level are extremely large for the model that assumes utility maximising choice behaviour.

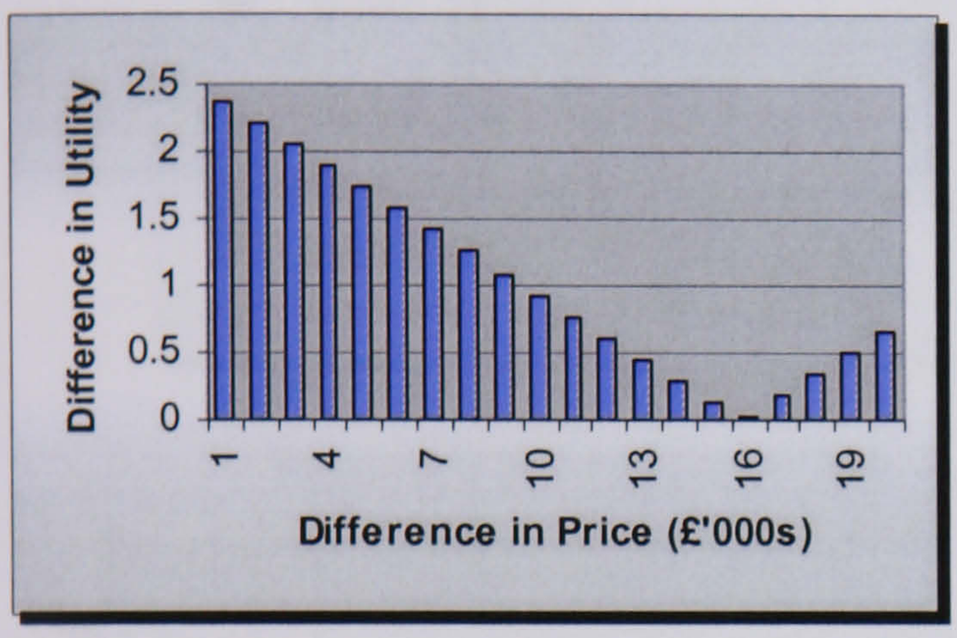


Figure 33: Difference in Estimated Utility from Assumed Values (Model Estimated Assuming Identified Choice Strategies)[7]

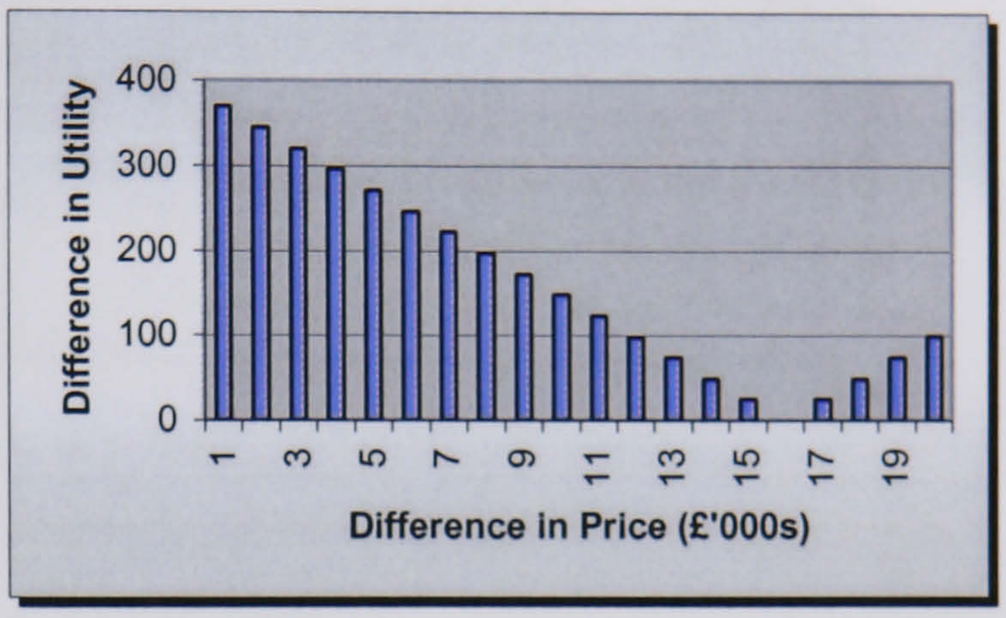


Figure 34: Difference in Estimated Utility from Assumed Values (Model Estimated Assuming Utility Maximising Choice Strategies)[8]

Figure 35 presents utility estimates for a series of values representing the difference in fuel efficiency between the vehicles represented within the stated preference experiments. The figure depicts the utility values estimated from the assumed model parameters, the model that was estimated from simulated response data using identified choice strategy, and the model that was estimated using the assumed utility maximising approximation. These models were again estimated from response data simulated assuming the 'text' choice strategy profile.

[7] For utility model estimated from data simulated from 'text only' parameter values, and 'text only' choice profile

[8] For utility model estimated from data simulated from 'text only' parameter values, and 'text only' choice profile

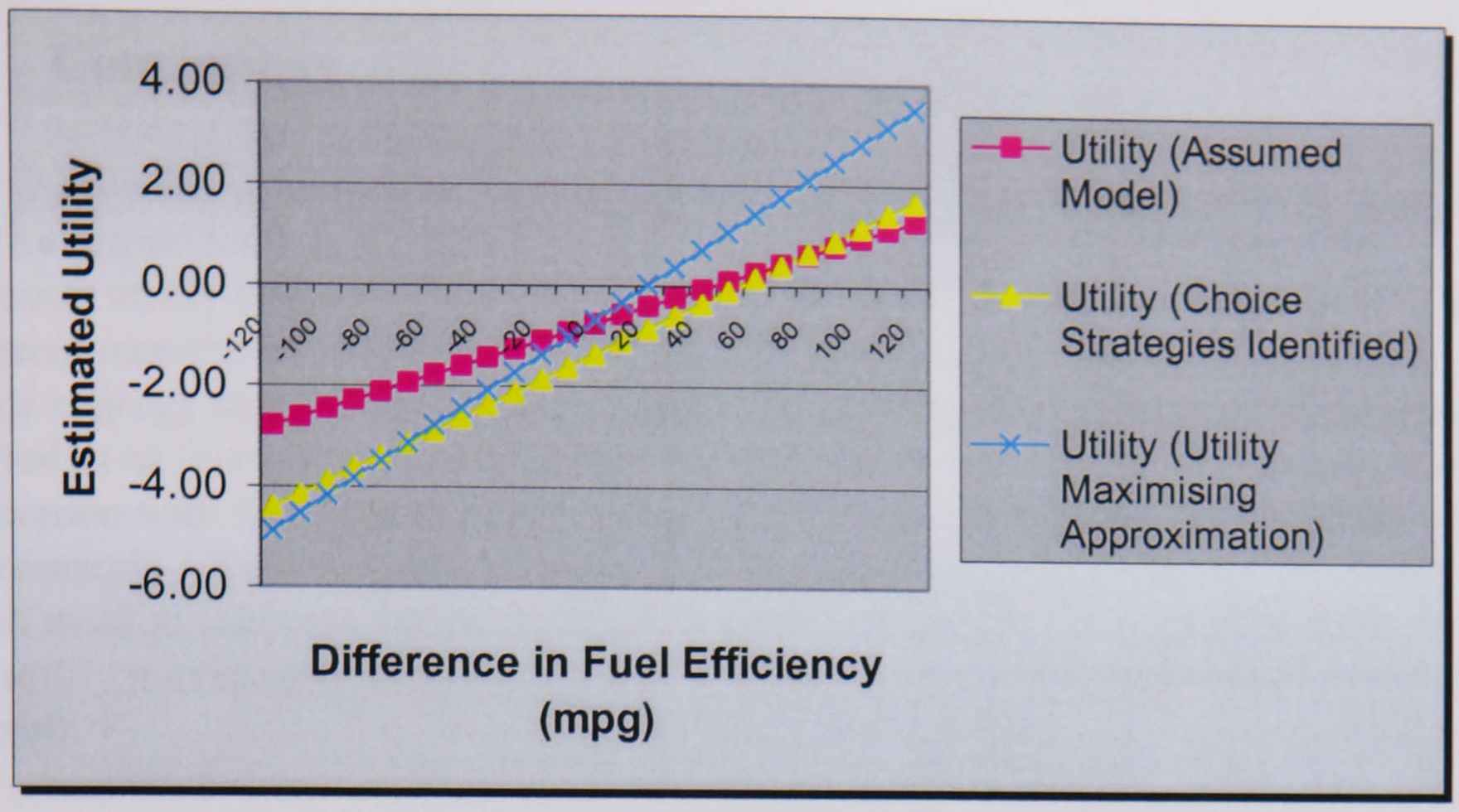


Figure 35: The Impact of Differences in Fuel Efficiency on Utility Estimates (Assumed 'Text Only' Parameter Values, 'Text only' Choice Profile)

The level of difference in the utility estimates presented above, when compared to the assumed values, is presented in figure 33 below. At the estimated difference in fuel efficiency between the two vehicles, which is 80pmg, the model that uses the utility maximising approximation exhibits a much higher level than the model that was derived through analysis that used the identified choice strategies.

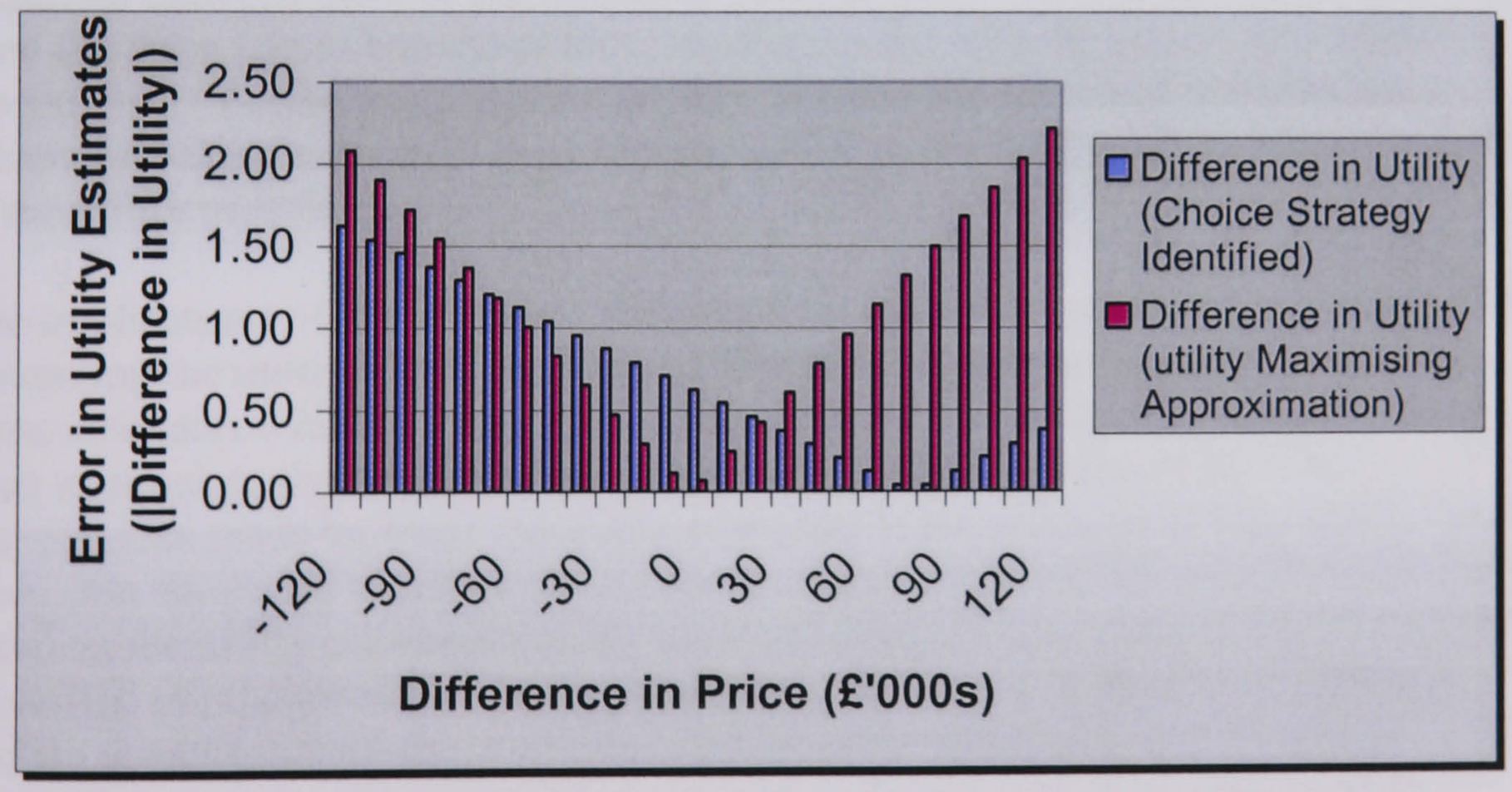


Figure 36: Impact of the Difference in Fuel Efficiency on the Difference in Utility Estimates (Assumed 'Text Only' Parameter Values, 'Text only' Choice Profile)

Discussion of the implications of the identified differences in parameter values, and resulting utility estimates is presented in the conclusions to this chapter in the following section.

8.6 Conclusions

This chapter has presented an investigation of the impact of differing choice strategies used by respondents in the stated preference experiments, on the estimation of consumer utility models. This was achieved through the analysis of data simulated to represent responses made by respondents employing choices strategies that mirror choice strategy profiles identified in chapter 6. These choice strategy profiles were referred to as 'text only', 'text&picture', and 'picture only' profiles, to signify their association with the three alternative stated preference experiments implemented in this research. Two alternative methods of data analysis were presented to assess which method achieves the most effective model estimation for responses made from non-utility maximising choice strategies. These two alternative methods of analysis differed:

- By representing the choice strategies identified as being used by respondents within the analysis of the response data
- By assuming that respondents employed utility maximising choice strategies to makes their choices

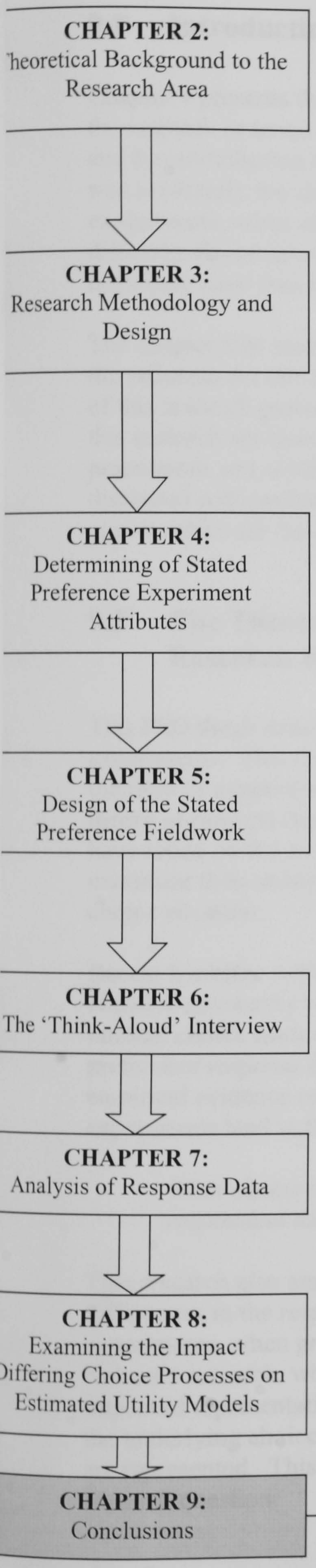
The utility models estimated from this simulated data, analysed in these two ways was then presented within the chapter. Comparisons between the models were made, in terms of the goodness of fit of the models, and differences in the parameter values between models *(addressing research question 3)*. Significant differences were identified between most of the estimated parameters for each of the models estimated from the three sets of simulated data, when analysed with the choice strategies represented. Furthermore significant differences were identified between the parameter values estimated using the alternative methods of analysis in the estimation of the utility models.

The implications of the identified differences in parameter values were examined by presenting the utility estimates for the different estimated models, and comparing those estimates with the utility values derived from the assumed parameter values used to simulate the response data *(addressing research question 3)*. The comparisons made between the utility estimates of the different utility models derived from data simulated to mirror the choice strategy profiles of the, identified differences between the utility estimates and the assumed utility values. Larger differences were identified in relation to the 'text only' sample. In chapter 6, the choice strategy profile associated with the 'text only' sample was explained to exhibit a high proportion on non-utility maximising choice strategies than the choice strategy profiles for the other samples. This suggests therefore that higher the level of non-utility maximising choices used by respondents, the high the level of inaccuracy of the utility estimates from the model derived from the response data. This directly addresses the third research question presented in this research.

Further examination of the utility estimates was also implemented to test the validity of the commonly used approximation of assuming that respondents use a utility maximising choice strategy, when analysing stated preference response data. Comparison of the parameter values, and then the utility estimates between models

that employ this assumption, and those that represent the identified choice strategies within the analysis found that larger differences existed between the utility estimates produced from the model that assumed utility maximising choice strategies were used by respondents. Changes in the value of the variable 'difference in price' in particular resulted in large changes in the estimated utility values for the model that assumed the use of utility maximising choice strategies. This would suggest that improvements in the utility model estimation from stated preference experiments could be made through the identification of choice strategies used by respondents, and used within the analysis of the response data.

CHAPTER 9: CONCLUSIONS


CHAPTER 2:
Theoretical Background to the Research Area
CHAPTER 3:
Research Methodology and Design
CHAPTER 4:
Determining of Stated Preference Experiment Attributes
CHAPTER 5:
Design of the Stated Preference Fieldwork
CHAPTER 6:
The 'Think-Aloud' Interview
CHAPTER 7:
Analysis of Response Data
CHAPTER 8:
Examining the Impact Differing Choice Processes on Estimated Utility Models
CHAPTER 9:
Conclusions
Conclusion Addressing the Research Questions, The Contribution to Knowledge, Critique of the Research, and Recommendations for Future Research

9.1 Introduction

Chapter 9 presents the conclusions of this Ph.D. research. The Chapter summarises the research in terms of its theoretical background, the setting of research questions and the contribution of the Ph.D. research to knowledge. The main aim of the research was to identify the choice strategies used by respondents during stated preference experiments, when attributes are represented in different ways. The impact of the differing choice strategies on the utility models estimated from stated preference responses were then examined.

The chapter first summarises the theoretical background to the research, and identifies the rationale for this thesis. The research questions are then re-stated and the findings of this research presented with reference to the research questions. The findings of this research are then discussed in terms of its contribution to knowledge to both the practitioner and academic audiences. The success of the research design is then discussed with problem areas and unresolved issues pointing to additional opportunities for further research.

9.2 The Theoretical Background to the Research Area and Research Rationale

This PhD thesis examines the way individuals make choices during stated preference experiments. This thesis described how stated preference techniques originate within the field of experimental economics and utility theory, and are underpinned by the theory of rational choice. This theoretical underpinning has meant that practitioners have relied on the assumption that respondents within stated preference experiments maximise their utility by trading off all the information presented to them within the choice situation.

Recent literature within the stated preference field, stemming from the concept of bounded rationality within the field of psychology, criticises the assumption of rational choice made by stated preference researchers in the analysis of stated preference response data (Ampt et al, 1995; 2000; Swanson, 1998). The lack of empirical evidence relating to how respondents make choices during stated preference experiments lead to the first of the research questions addressed in this thesis:

> *What choice strategy is used for each choice scenario presented to the respondent during a stated preference experiment?*

This research also aims to further research by Nelson (1992, 1998) that identified differences in the responses made by individuals within stated preference experiments, when presented with attributes that were represented in different ways. Nelson's research, whilst providing an important contribution in questioning the impact of representation type on the choices made by respondents, failed to uncover the underlying choice process of respondents in response to way in which attributes are represented. This is the second area examined by this research, addressing the research question:

Does the way attributes are represented, using text, pictures or text and pictures, affect the choice strategy employed by a respondent during a stated preference experiment?

The third research question presented within this thesis examines the impact of the identified choice processes used by respondents on the estimation of consumer utility models. This question is addressed in order to consider the importance of understanding consumer choice strategies in the use of stated preference experiments. The third research question addressed in this research is:

Does the choice strategy employed by respondents during stated preference experiments affect the estimation of resulting consumer utility models?

The following section presents a summary of findings of the research, by directly addressing these three research questions.

9.3 Presentation of the Research Findings in the Context of the Research Questions

9.3.1 Addressing Research Question 1

The first research question presented within this research was:

What choice strategy is used for each choice scenario presented to the respondent during a stated preference experiment?

Chapter 6 described the design, implementation and analysis of think aloud protocol, implemented within the context of three different stated preference experiments. Each of these stated preference experiments, which presented a purchasing choice between two new vehicles, represented the attribute 'vehicle appearance' in different ways, using:

- Text only
- Text and picture
- Picture only

The analysis of the think aloud protocols allowed the identification of the choice strategy used by each respondent for each choice scenario presented to them during the stated preference experiment, and so directly addressing *research question 1*. Choice strategies used by respondents were compared to choice strategies defined within literature:

- *Utility maximising choice strategies* are those usually assumed by stated preference practitioners. This means that respondents are believed to attach weightings to each/all of the attributes in a choice situation. It is assumed that the option with the highest total utility will therefore be chosen.

- *Dominance-based choice processes* are those where people select an option that is valued higher than all other alternatives on each attribute. For example, for the choice scenarios presented during the stated preference experiments during this research, an individual would identify which vehicle was preferred, when valuing the choice based on only one of the attributes at a time. Which vehicle has the preferred appearance? Which vehicle has the preferred price? This would continue for all attributes presented within the choice scenario. This kind of choice strategy would clearly be likely not produce a single solution.

- *Maximax* and *maximin* choice strategies. People who use a maximin choice strategy identify the attribute that has the greatest negative impact upon the their total utility evaluation, and then choose the alternative that has the highest level of satisfaction (utility). People using a maximax strategy identify the attribute that has the greatest positive impact on a total utility evaluation and then chooses the option that provides the highest level of satisfaction (utility) from this attribute. This would not necessarily produce a single solution.

- *Lexicographic choice strategies* are those used when a person hierarchically orders all the attributes of choices they are about to make into the order that has the most influence upon their total utility evaluation, and then chooses the alternative with the highest value on the most important attribute. Here travel choices of this type are easy to find, for example the person for whom travel time is critical will choose the quickest journey over all other attributes.

- *Conjunctive choice strategies* are those made when a person rejects any alternative that fails to meet anyone of the minimum criterion of acceptability. This means that the individual sets an acceptable level for each attribute and rejects any alternative where the level/levels are not met. Conversely *disjunctive* choice strategies result in the acceptance of any alternative exceeding a certain criterion. Again this will not always give a single solution.

Not all choice strategies used by respondents within the stated preference experiments implemented within this research could be accurately identified against this predefined list. However all choice strategies *could* be categorised as utility maximising and non-utility maximising choice strategies. The non-utility maximising choice strategies were further categorised into three types:

- Lexicographic choice strategies
- Conjunctive choice Strategies
- Unidentified, but non-utility maximising choice strategies

No further choice strategies were identified from the think-aloud interview data. Of the choice strategies identified from literature, neither dominance based choice strategies nor maximax or maximin choice strategies, were identified as being used by respondents within the think aloud interviews. Respondents were asked to state their preference between two vehicles (and therefore highlight their preference for *one* vehicle). However, dominance based and maximax and maximin strategies cannot

guarantee only one solution. It is likely therefore, that the type of task presented to the respondents (which required them to select only one preferred vehicle) caused respondents not to use these strategies.

Examination of the identified choice strategies used during the stated preference experiments also found a significant association between the choice strategy used by the respondent and the presentation order of the choice scenarios within the experiments implemented within this research. This relationship showed a declining used of utility maximising choice strategies as the experiment progressed. A summary of the percentage of choices made using utility maximising choice strategies in each of the stated preference experiments is presented in table 37 below.

	% of Utility Maximising Choice Strategies		
Choice Scenario Presentation Order	**'Text only' experiment**	**'Picture and Text' experiment**	**'Picture only' experiment**
1	87.5	95	97.5
2	85	90	92.5
3	72.5	77.5	85
4	22.5	70	82.5
5	10	27.5	55
6	0	7.5	30
7	0	2.5	5
8	0	2.5	0
9	0	0	0
10	0	0	0
11	0	0	2.5
12	0	0	0
13	0	0	0
14	0	0	0
15	0	0	0
16	0	0	0

Table 37: Utility Maximising Choice Strategies Used by Respondents

Chapter 6 discussed the possible reason for this decline in the use of utility maximising choice strategies. The impact of respondent fatigue on the level of decision-making was described, and conclusion made that respondent fatigue would be likely to reduce the level of utility maximising choice strategies by respondents. Whilst previous research (e.g. Pearmain et al, 1991) suggests that an experiment should include a maximum limit of 16 choice cards to avoid the existence of respondent fatigue, this research suggests that this might occur much earlier. From the fifth choice onwards, less than 50% of all the choice strategies used by respondents during each of the three experiments was utility maximising. This would suggest that to ensure that respondents use utility maximising choice strategies (as is commonly assumed in stated preference analysis), the number of choice cards presented to respondents needs to be increased to a very low level.

9.3.2 *Addressing Research question 2*

The second research question presented within this research was:

> *Does the way attributes are represented, using picture or text, affect the choice strategy employed by a respondent during a stated preference experiment.*

In chapter 6, analysis of the choice strategies used by respondents during the stated preference experiments identified a significant association between the choice scenario presentation number and the use of utility maximising choice strategies and lexicographic choice strategies. Further analysis was then undertaken that directly addressed the second research question presented above.

A series of tests were carried that tested whether there was a significant difference between the proportion of choices that use utility maximising choice strategies for each choice, for each presentation choice number for each of the stated preference experiment types used. All three sample-groups ('text only', 'text&picture', and 'pictures only') exhibit a downward trend in the use of utility maximising choice strategies during the 16 choices presented to respondents. However, differences exist in the percentage of respondents using utility maximising choice strategies within each of the sample groups, for the first to eighth choice scenarios presented during the stated preference experiments.

At choice number 4, both the 'text only' and 'picture&text only' comparison, and the 'text only' and 'picture only' comparison exhibit significant differences in the proportion of choices using a utility maximising choice strategy. At choice number 5 and 6, all of the comparisons made exhibit significant differences. Particularly large differences are apparent between the 'text only' and 'picture only' sample groups, where the picture sample group has a significantly higher number of choices using utility maximising choice strategies.

The impact of these identified choice strategy profiles (the set of choice strategies used by the respondents in each sample group) addresses the third research question, and is discussed in the following section.

9.3.3 *Addressing Research Question 3*

The third research question presented within this research was:

> *Does the choice strategy employed by respondents during stated preference experiments affect the estimated utility models, and resulting utility estimates?*

Chapter 6 identified differences in the choice strategies used by respondents in each of the stated preference experiments. Chapters 7 and 8 of this thesis aimed to assess the impact of these identified differences on the impact of consumer utility models.

Chapter 7 analysed the response data collected during the three stated preference experiments. Examination of these utility models identified significant differences in

the parameter values between the three models. The influence of representation type was also tested by using dummy variables to represent the experiment type ('text', 'text&picture', and 'picture only') in the estimation of a model that was derived from the full data set. These dummy variables were found to have a significant impact on the utility model estimated from the full data set, suggesting that attribute representation type does have a significant impact on the estimation of utility models. These findings supported research by Nelson (1992; 1998) that identified a relationship between the representation of attributes within the stated preference experiments and the estimated utility models. However analysis of the elicited response data could not separate out the impact of the identified respondent choice strategies associated with each stated preference experiment on the estimated models. Differences in the estimated utility models associated with each of the attribute representation types were considered to be the result of several alternative possible reasons:

- **Different sets of preferences held between the three different sample groups.**
  Whilst it is expected that there is variation in preferences across a sample group, if the variation differs between each of the sample groups then this will impact on the responses elicited for each of the sample groups and therefore the estimated model parameters.

- **Differences in the way the alternatively represented attributes were comprehended by the three different sample groups.**
  As one of the vehicles (the ASCC) represented in the choice scenarios presented to respondents was a vehicle that is not currently available or known in the marketplace, respondents who were shown the text only choice card may have held a different mental image of the vehicle described to those respondents who were presented a picture of the vehicle.

Given the limitations of the analysis presented in chapter 7 in addressing the third research question, chapter 8 presented the creation and response data. Responses were simulated to represent choices made using those choices strategies identified as being in chapter 6 as being used by individuals within each of the three different stated preference experiments implemented within this research. This simulation allowed a controlled investigation into the impact of differing choice strategies used by respondents in stated preference experiments, on the estimation of consumer utility models.

Utility models estimated from sets of response data, simulated using different choice strategy profiles, exhibited significantly different model parameters.
Significant differences were identified between most of the estimated parameters for each of the models estimated from the three sets of simulated data, when analysed with the choice strategies represented. Furthermore significant differences were identified between the parameter values estimated using the alternative methods of analysis in the estimation of the utility models.

The implications of the identified differences in parameter values were examined by presenting the utility estimates for the different estimated models, and comparing those estimates with the utility values derived from the assumed parameter values

used to simulate the response data *(addressing research question 3)*. The comparisons made between the utility estimates of the different utility models derived from data simulated to mirror the choice strategy profiles of the, identified differences between the utility estimates and the assumed utility values. Larger differences were identified in relation to the 'text only' sample. In chapter 6, the choice strategy profile associated with the 'text only' sample was explained to exhibit a high proportion on non-utility maximising choice strategies than the choice strategy profiles for the other samples. This suggests therefore that higher the level of non-utility maximising choices used by respondents, the high the level of inaccuracy of the utility estimates from the model derived from the response data.

Further examination of the utility estimates was also implemented to test the validity of the commonly used approximation of assuming that respondents use a utility maximising choice strategy, when analysing stated preference response data. Comparison of the parameter values, and then the utility estimates between models that employ this assumption, and those that represent the identified choice strategies within the analysis found that larger differences existed between the utility estimates produced from the model that assumed utility maximising choice strategies were used by respondents. Changes in the value of the variable 'difference in price' in particular resulted in large changes in the estimated utility values for the model that assumed the use of utility maximising choice strategies. This would suggest that improvements in the utility model estimation from stated preference experiments could be made through the identification of choice strategies used by respondents, and used within the analysis of the response data.

9.4 Contribution to Knowledge

9.4.1 Consumer Behaviour

This thesis has highlighted an important difference in the conceptualisation of the term 'rationality' between economists and psychologists working within the field of consumer behaviour. *'In economics, rationality is viewed in terms of the choices it produces; in the other social sciences it is viewed in terms of the processes it employs'* (Simon, 1976, 1982). Economists describe individuals as seeking to maximise the utility gained from the choices, whilst research by psychologists examining consumer behaviour emphasise the limits to individuals' ability to maximise their utility because:

- Their rationality is bounded by limits on their information processing skills (Simon, 1976; 1982).
- Their motivation to engage in substantial mental effort to undertake extensive problem solving (Foxall, 1990; Eysenck and Keane, 2001; Mittal, 1989)

This research contributes to this academic debate by gathering empirical evidence of the choice strategies employed by respondents in stated preference experiments. The nature of these choices being examined, *repeated hypothetical choices*, has received lacked empirical evidence within the limited research attention that this subject has received. Whilst some researchers suggested that for individuals would hold only levels of motivation to engage in problem solving to hypothetical choices (Swanson,

1998; Ampt et al, 1985; 2000), no empirical evidence could be identified within the literature to directly support this.

The findings of this research present mixed results. Individuals use a both utility maximising, and non-utility maximising choice strategies within stated preference experiments. However the frequency of the use of utility maximising choices sharply reduces as repeated choices are presented to a respondent. This research therefore makes an important contribution in identifying that respondents frequently deviate from the concept of rational choice, within the context of hypothetical choice situations.

The next section considers the contribution of the research findings for the practice of stated preference research.

9.4.2 Stated Preference Research

Chapter 1 explained that stated preference techniques originated within the field of experimental economics and utility theory in the first half of the twentieth century. The positioning of their development within this field explains their reliance on the concepts of rational behaviour that explains the economist's view of individual choice behaviour. This assumption of rational choice made by individuals has lead stated preference practitioners to assume that respondents within stated preference experiments maximise their utility from a choice, by trading off against each other the different attributes that described a choice scenario. This assumption has meant that stated preference practitioners estimate consumer utility by inferring individuals' utility weightings from their responses to differences in the attributes in the stated preference choice scenarios.

The research presented in this thesis identified choice strategies employed by respondents during three stated preference experiments, which presented choice scenarios relating to the choice between two new vehicles. These three stated preference experiments presented the attribute 'vehicle appearance' in three different ways, using 'text only', 'text&picture' or 'pictures only'. The choice strategies identified as being used by respondents in all of the experiments showed a high degree of non-utility maximising choice strategies – in direct contradiction to the commonly adopted assumptions made by stated preference practitioners. In particular those respondents that were presented the 'text only' sample exhibited a higher level of non-utility maximising choice strategies.

The level of non-utility maximising choice strategies increased as the experiment progressed for each of the sample groups. As discussed in chapter 6 and section 9.3.2, a possible reason for this declining use of utility maximising choice strategies is the existence of respondent fatigue. Whilst previous research suggests a maximum limit of 16 choice cards being presented to respondents during a stated preference experiment (Pearmain et al, 1991), the research findings presented within this thesis would suggest that a much lower level (below 5) would be required to ensure that most choice strategies employed by respondents were utility maximising.

Simulation techniques were also employed as part of this research that allowed the conditions of the stated preference experiment to be controlled, and so identify:

- The impact of these identified non-utility maximising choice strategies on the estimation of consumer utility models and associated utility estimates;
- The impact that different methods of analysis have on the estimation of consumer utility models and associated utility estimates.

Differences in the identified choice strategy profiles (the choice strategies associated with the different stated preference experiments implemented in this research) were found to have a significant impact on the estimated utility models and associated utility estimates. The choice strategy profile associated with the 'text only' experiment was found to exhibit larger differences between the estimated model parameters and the assumed parameter values used as an input into the simulation. Examination of the associated utility estimates produced from the estimated models also exhibited large differences when compared to those estimated from the parameter values used as inputs to the simulation. This evidence suggests therefore that for the choice context examined within this research, that the use of pictures to represent the appearance of the vehicles presented in the choice scenarios produces utility models of greater accuracy. This supports guidelines within the stated preference field that suggests that the use of pictures can aid the presentation of more qualitative attributes in choice scenarios (Pearmain et al, 1991; Swanson, 1998; Green and Srivinsen, 1978).

This thesis presents a further contribution to stated preference practice in the research findings relating to the use of alternative methods for analysing of stated preference response data. This research considered the validity of employing the assumption of utility maximising choice strategies as a suitable approximation during the analysis of the stated preference response data. Models estimated using data analysed using this assumption, and were compared with those estimated where the identified choice strategies were represented (this method was explained in section 7.2.4). Significant differences were found between the estimated model parameters, and associated utility values using the two methods. The models that were estimated from analysis that assumed utility maximising choice strategies, exhibited larger differences between the estimated model parameters (and associated utility values) and those assumed values used as inputs into the simulation, than those models estimated using analysis that represented the identified choice strategies. This leads to the recommendation for practitioners to identify the choice strategies used by respondents during stated preference experiments, and for these strategies to be identified within the analysis.

9.5 Critique of the Research

The previous section presented the contribution that this PhD research makes to the field of consumer behaviour, and also to the practice of stated preference techniques. However, as well as highlighting the successes of the research, it is important to understand its limitations. This section therefore provides a critique of the research presented in this thesis, in terms of the research design implemented and the generalisability of the findings. The limitations that are highlighted within this

critique lead to opportunities for further research, which are summarised within the next section.

This research aimed to identify the choice strategies employed by respondents in stated preference experiments, and determine whether these were affected by the way in which attributes within the experiment are represented. To be able to identify these choice strategies, it was considered necessary that this research be conducted within the context of a stated preference experiment (as explained in chapter 3). This research presented respondents with a purchasing decision between two vehicles. This choice context was considered an appropriate subject for the research, because it represented a purchase that is considered to hold a high level of consumer involvement, which was considered likely to encourage respondents to engage in utility maximising choice strategies. As the type of choice context is considered likely to influence the choice strategies used by respondents, it is likely that the identified choice strategies described in this research would differ to those related to other choices presented to a respondent. The findings of this research (in terms of the proportion of utility maximising choices made within the stated preference experiments) may not be generalised across other choice situations.

The stated preference experiments used as the context of this research presented 6 different attributes relating to the vehicles presented (including the difference in appearance of the vehicles, which was held constant). Stated preference experiments can incorporate differing numbers of attributes within the presentation of choices, and is likely that this degree of complexity might impact on the choice strategies employed by the respondent. Therefore, whilst the research provides a useful contribution in identifying the large-scale use of non-utility maximising choice strategies by respondents within this research, the exact proportions of their usage cannot be generalised for all designs of stated preference experiments.

To identify the impact of differing ways of representing the attributes within a stated preference experiment, on the choice strategies employed by a respondent, this research presented the attribute 'vehicle appearance' in different ways within the three experiments implemented (text only, text&pictures, or pictures only). The attribute 'vehicle appearance' is difficult to describe in text, and lends itself well to be represented in pictures. The difference in choice strategies identified between the different experiments, as a result of differing methods of representing this vehicle appearance, may not have been so great, for different types of attribute.

The different ways of representing attributes within this research used text, text&picture, and pictures. Identifying differing impacts on choice strategies between these types of representation provides an important contribution to the area of stated preference practice (as explained in the previous section). However there are many more ways of representing different attributes, including graphs, diagrams, sound, and even video clips. This research therefore presents only initial limited findings within this area of the impact of attribute representation on the choice strategies employed by respondents.

This section has presented a number of identified limitations to how widely research reported within this thesis may be generalised. However, the research findings of this research present an important contribution to an area that has received little research

attention, and these identified limitations should be viewed as opportunities for future research. Recommendations for future research, stemming from these limitations, are summarised in the following section.

9.6 Recommendations for Future Research

In light of the critique presented in the previous section, a number of the recommendations for further research following on from this thesis are as follows:

- **Identification of Choice Strategies Used by Stated Preference Respondents in Other Choice Contexts**
  Given the impact the type of choice has on the motivation of individuals to engage in complex problem solving, it is recommended that the findings of this research be tested in different research contexts. For example, the presentation of choices that are related to purchasing decisions for products that are considered to yield a lower level of consumer involvement, may result in an even lower level of utility maximising choice strategies than that employed in this research.

- **Identification of Choice Strategies Used by Respondents in Other Designs of Stated Preference Experiments**
  Given the number of attributes presented to a respondent, impacts on the complexity of the choice task they are undertaking, it is likely to impact on the choice strategies employed. An important area for future research would be to identify the impact on choice strategies of the number of attributes included within stated preference experiments.

- **Alternative Ways of Representing Different Types of Attributes and the Impact on Choice Strategies Used by Respondents**
  This research focused on three different ways of representing the attribute vehicle appearance. The significant findings of this research provides the opportunity for further research within this area, examining the impact of other ways of representing attributes, and on other types of attribute. Such research would directly inform the practice of stated preference experiments.

This section has highlighted a number of opportunities for future research. The following section provides a brief summary of the areas discussed within this chapter.

9.7 Summary of the Conclusions

This chapter has presented the conclusions to this thesis. The research questions, and the research rationale were represented, before a summary of the findings was presented with reference to each of the research questions. The successes of the research were then discussed in terms of the contribution made to field of consumer behaviour research, and to the practice of stated preference experiments. Finally, a critique of the research presented in this thesis, in terms of the research design implemented, and the research findings. The limitations that were highlighted within this critique lead to the identification of opportunities for further research.

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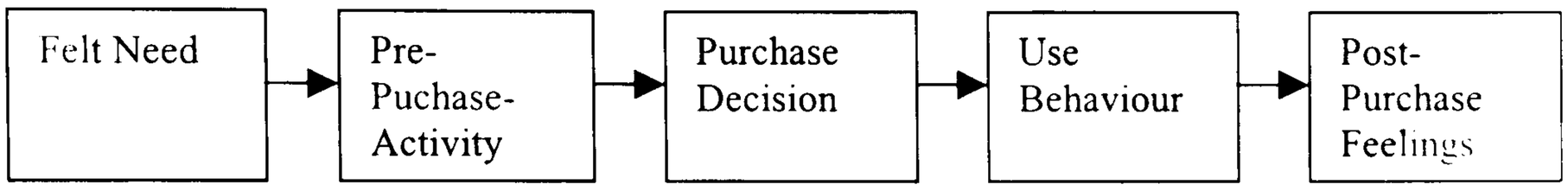
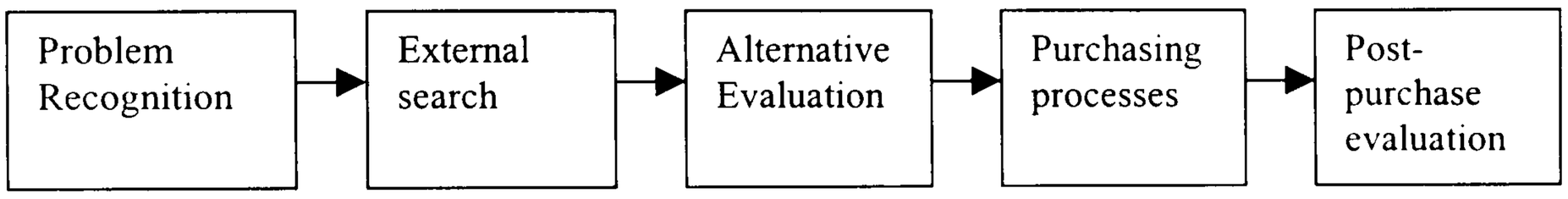
APPENDICES

Appendix A: Process Models of Decision Making



Kotler's Decision Process Model (Source: Kotler, 1967)

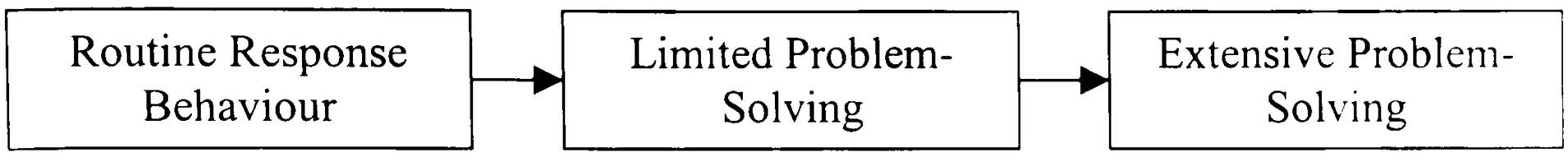


Engel, Kollat and Blackwell's Decision Process Model (Engel, Kollat and Blackwell ,1968)

Appendix B: Early Information Processing Models of Consumer Choice
(Adapted from Foxall, 1983; Tuck, 1976)

Author (s)	Year	Sequence
Lionberger Rogers	1960 1962	Seeing ⇒ Reading ⇒ Believing ⇒ Remembering ⇒ Acting
Colley	1961	Unawareness ⇒ Awareness ⇒ Comprehension ⇒ Conviction ⇒Action
Lavidge and Steiner	1961	Awareness ⇒ Knowledge ⇒ Liking ⇒ Preference ⇒ Conviction ⇒ Action
McGuire	1969	Exposure ⇒ Attention ⇒ Comprehension ⇒ Conviction ⇒ Action
Howard and Sheth	1969	Attention ⇒ Brand Comprehension ⇒ Attitude ⇒ Intention ⇒ Purchase
Rogers and Shoemaker	1971	Knowledge ⇒ Persuasion ⇒ Decision ⇒ Confirmation
McGuire	1976	Exposure ⇒ Perception ⇒ Comprehension ⇒ Agreement ⇒ Retention ⇒ Retrieval ⇒ Decision Making ⇒ Action
Britt	1978	Exposing ⇒ Attending ⇒ Perceiving ⇒ Learning and Remembering ⇒ Motivating ⇒ Persuading ⇒ Desired Action

Appendix C: A continuum of Buying Decision Behaviour (Solomon, 2000)



Low-cost products	More expensive products
Frequent purchasing	Infrequent purchasing
Low consumer involvement	High consumer involvement
Familiar product class and brands	Unfamiliar product class and brands
Little thought, search or time given to purchase	Extensive thought, search and time given to purchase

Appendix D: Example Fieldwork Materials: Pre-Stated Preference Research

Interview Date:

Interview Location

Respondent Age:

17 – 30	☐	Male	☐
30 – 40	☐	Female	☐
40 – 50	☐		
50 – 60	☐		
60+	☐		

What factors do you consider in your decision to purchase a particular type of new car?

Appendix D cont: Example Fieldwork Materials: Pre-Stated Preference Research

Summary of Elicited Underlying Meanings from Respondents

Elicited Attributes	Underlying Meaning of Attributes (Secondary Attributes)	Underlying Meaning of Secondary Attributes

Appendix E: Correlation Matrix

	Price of ASCC	Body Type of ASCC	Fuel efficiency of ASCC	No. of doors of comparison	Fuel type of ASCC
Price of ASCC	1				
Body Type of ASCC	0.0916949301	1			
Fuel efficiency of ASCC	0.070534562	-0.33333	1		
No. of doors of comparison	0	0	0	1	
Fuel type of ASCC	0	0	0	0	1

Appendix F: Estimated Utility Model From Pilot Response Data and An Example of the Simulation Results for the SP Design Tests

$R^2 = 0.43$		
Attribute	**Parameter**	**T Signif. @ P=0.05?**
Intercept	-0.13	Yes
Difference in Price	-0.09	Yes
Difference in Body Type	0.224	No
Difference in Body Type	-0.266	No
Difference in Fuel Efficiency	0.011	Yes
Difference in No of doors	-0.234	No
Difference in Fuel Type	-0.192	No

Attributes of the ASCC for the Simulation				
Price of ASCC = 18000	Body Type of ASCC =Carbon	Fuel efficiency of ASCC = 120mpg	No. of doors of comparison = 3	Fuel type of ASCC = Diesel

	Utility Values
Test 1	
Assumed Utility (AU)	0.242
Simulated Estimate (SE)	0.311
Test 2	
AU	0.289
SE	0.344
Test 3	
AU	0.312
SE	0.402
Test 4	
AU	0.431
SE	0.499
Test 5	
AU	0.522
SE	0.701
Test 6	
AU	0.623
SE	0.899

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Appendix G: Example Fieldwork Materials: Stated Preference Research and Think-Aloud Protocol

Interview Date:

Interview Location

Respondent Age:

17 – 30	☐	Male	☐
30 – 40	☐	Female	☐
40 – 50	☐		
50 – 60	☐		
60+	☐		

VW Golf	VW	Comment
Appearance	Appearance	
Price	Price	
Body Type	Body Type	
Fuel Efficiency	Fuel Efficiency	
No of doors	No of doors	
Fuel Type	Fuel Type	

Appendix H: R^2 Terms Associated with the Estimated Utility Models

Sample	R^2 Values	
	Derived from Elicited Response Data	Derived from Simulated Data ('Text &Picture' Parameter Values Assumed)
Text only	0.4743	0.8421
Text&Picture	0.5290	0.8501
Picture only	0.5218	0.8400

Sample	R^2 Values	
	Derived from Elicited Response Data	Derived from Simulated Data ('Picture only' Parameter Values Assumed)
Text only	0.4743	0.8134
Text&Picture	0.5290	0.8381
Picture only	0.5218	0.8295

Appendix I: Two-tail T-Tests Between the Parameter Values Estimated from the Simulated Data Sets

'Text&Picture' Assumed Model Parameters:

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	'Text only' Choice Strategy Profile	'Text&Picture' Choice Strategy Profile		
Intercept	-1.67769	-2.10698	-49.01	yes
Difference in Price	-0.17635	-0.13663	-2.64	yes
Difference in Body Type	0.110504	0.207386	-8.21	yes
Difference in Body Type	-0.20333	-0.6869	-75.21	yes
Difference in Fuel Efficiency	0.034087	0.024763	41.18	yes
Difference in No of doors	-0.83347	-0.28034	-63.12	yes
Difference in Fuel Type	0.004265	0.365106	41.64	yes

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	'Text&Picture' Choice Profile	Picture' Choice Profile		
Intercept	-2.10698	-2.06879	-1.21	no
Difference in Price	-0.13663	-0.13771	-0.96	no
Difference in Body Type	0.207386	0.111634	6.31	yes
Difference in Body Type	-0.6869	-0.64392	-2.64	yes
Difference in Fuel Efficiency	0.024763	0.025014	2.31	yes
Difference in No of doors	-0.28034	-0.32871	-7.82	yes
Difference in Fuel Type	0.365106	0.372956	0.86	no

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	'Picture' Choice Profile	'Text' Choice Profile		
Intercept	-2.06879	-1.67769	-45.61	yes
Difference in Price	-0.13771	-0.17635	28.64	yes
Difference in Body Type	0.111634	0.110504	0.035	no
Difference in Body Type	-0.64392	-0.20333	-41.19	yes
Difference in Fuel Efficiency	0.025014	0.034087	69.21	yes
Difference in No of doors	-0.32871	-0.83347	48.03	yes
Difference in Fuel Type	0.372956	0.004265	35.86	yes

Appendix I cont.

'Picture' Assumed Model Parameters:

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	'Text only' Choice Strategy Profile	'Text&Picture' Choice Strategy Profile		
Intercept	-0.97909	-1.51187	-49.01	yes
Difference in Price	-0.26275	-0.20169	-2.64	yes
Difference in Body Type	0.280009	0.287052	-8.21	yes
Difference in Body Type	-0.33533	-0.22353	-75.21	yes
Difference in Fuel Efficiency	0.030866	0.034275	41.18	yes
Difference in No of doors	-1.02702	-0.91534	-63.12	yes
Difference in Fuel Type	-0.01273	-0.03315	41.64	yes

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	'Text&Picture' Choice Profile	Picture' Choice Profile		
Intercept	-1.51187	-1.24922	-3.39	yes
Difference in Price	-0.20169	-0.28477	-1.01	no
Difference in Body Type	0.287052	0.309119	4.85	yes
Difference in Body Type	-0.22353	-1.0292	-8.44	yes
Difference in Fuel Efficiency	0.034275	0.024819	5.64	yes
Difference in No of doors	-0.91534	-0.32687	-28.23	yes
Difference in Fuel Type	-0.03315	0.051681	-7.25	yes

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	'Picture' Choice Profile	'Text' Choice Profile		
Intercept	-1.24922	-0.97909	-39.21	yes
Difference in Price	-0.28477	-0.26275	-2.34	yes
Difference in Body Type	0.309119	0.280009	0.048	no
Difference in Body Type	-1.0292	-0.33533	-22.12	yes
Difference in Fuel Efficiency	0.024819	0.030866	4.12	yes
Difference in No of doors	-0.32687	-1.02702	-53.88	yes
Difference in Fuel Type	0.051681	-0.01273	23.28	yes

Appendix J: Two-tail T-Tests Between the Parameter Values Comparing Alternative Methods of Analysis

'Picture' Assumed Model Parameters:

Text Choice Strategy Profile

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	Assuming Utility Maximising Choice	Representing the Identified Choice Profile		
Intercept	66.38997	-0.97909	-16469.21	yes
Difference in Price	16.73615	-0.26275	-12762.34	yes
Difference in Body Type	-169.356	0.280009	-15870.48	yes
Difference in Body Type	-67.961	-0.33533	-1722.12	yes
Difference in Fuel Efficiency	0.034553	0.030866	24.32	yes
Difference in No of doors	-0.93507	-1.02702	-51.08	yes
Difference in Fuel Type	-0.08301	-0.01273	-23.21	yes

Text&Picture Choice Strategy Profile

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	Assuming Utility Maximising Choice	Representing the Identified Choice Profile		
Intercept	83.5413	-1.51187	-1849.06	yes
Difference in Price	21.05229	-0.20169	-1672.64	yes
Difference in Body Type	-212.448	0.287052	-1742.29	yes
Difference in Body Type	-85.2145	-0.22353	-1145.21	yes
Difference in Fuel Efficiency	0.03444	0.034275	31.12	yes
Difference in No of doors	-0.91296	-0.91534	-23.12	yes
Difference in Fuel Type	0.025339	-0.03315	21.67	yes

Picture Choice Strategy Profile

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	Assuming Utility Maximising Choice	Representing the Identified Choice Profile		
Intercept	78.83321	-1.24922	-1974.21	yes
Difference in Price	19.86847	-0.28477	-1172.6	yes
Difference in Body Type	-200.656	0.309119	-1732.295	yes
Difference in Body Type	-80.4439	-1.0292	-1587.21	yes
Difference in Fuel Efficiency	0.034231	0.024819	11.02	yes
Difference in No of doors	-0.93953	-0.32687	-17.12	yes
Difference in Fuel Type	-0.00733	0.051681	26.17	yes

Appendix J Cont.

'Text&Picture' Assumed Model Parameters:

Text Choice Strategy Profile

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	Assuming Utility Maximising Choice	Representing the Identified Choice Profile		
Intercept	217.8255	-1.67769	-1975.06	yes
Difference in Price	54.87157	-0.17635	-1289.62	yes
Difference in Body Type	-550.036	0.110504	-963.21	yes
Difference in Body Type	-220.502	-0.20333	-1300.29	yes
Difference in Fuel Efficiency	0.025422	0.034087	19.18	yes
Difference in No of doors	-0.28773	-0.83347	-14.11	yes
Difference in Fuel Type	0.520007	0.004265	41.61	yes

Picture&Text Choice Strategy Profile

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	Assuming Utility Maximising Choice	Representing the Identified Choice Profile		
Intercept	214.7967	-2.10698	-1525.36	yes
Difference in Price	54.09534	-0.13663	-1112.44	yes
Difference in Body Type	-542.334	0.207386	-1343.69	yes
Difference in Body Type	-217.51	-0.6869	-914.21	yes
Difference in Fuel Efficiency	0.024136	0.024763	23.02	yes
Difference in No of doors	-0.24578	-0.28034	-32.11	yes
Difference in Fuel Type	0.515447	0.365106	16.22	yes

Picture Choice Strategy Profile

Variable	Estimated Parameter Values		t-value	Significant Difference at 0.05?
	Assuming Utility Maximising Choice	Representing the Identified Choice Profile		
Intercept	32.16843	-2.06879	-1649.06	yes
Difference in Price	8.040698	-0.13771	-1981.64	yes
Difference in Body Type	-83.0832	0.111634	-1112.36	yes
Difference in Body Type	-34.1917	-0.64392	-1000.12	yes
Difference in Fuel Efficiency	0.025435	0.025014	15.36	yes
Difference in No of doors	-0.35205	-0.32871	-32.69	yes
Difference in Fuel Type	-0.03119	0.372956	11.30	yes